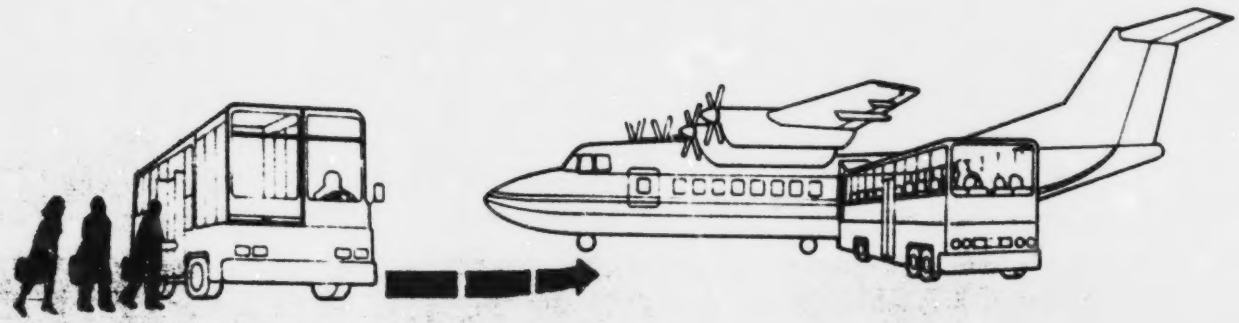
TP+ 6429E

MOBILE AIR TERMINAL RESEARCH

Transportation Development Centre

Canada



h 1985

CA1
DTC 849
85
M51
c.2

IBI Group
In Association With:
GSM Design Inc.

TP 6429 E

MOBILE AIR TERMINAL RESEARCH

by

IBI GROUP

Associated Consultant

GSM DESIGN INC.

Library and Information Centre
Centre de Documentation (GSL)
RECEIVED – REÇU LE
SEP 19 1985
Government Publication Officielle
Transport Canada / Transports Canada

Authors

George Sladek
Carol Soukup

March 1985

The contents of this report reflect the opinions of the Consultants and are not to be construed as the official policy of the Transportation Development Centre.

Dimensions and measurements contained in this report may appear in both imperial and metric quantities as a reflection of common usage and standard practice of the aviation and bus industries.

REPORT DOCUMENTATION FORM

1. Transport Canada Report No.	2. TDC Project No.	3. Recipient's Catalogue No.
TP 6429E	6183	

4. Title and Subtitle	5. Report Date
MOBILE AIR TERMINAL RESEARCH	March 1985
	6. Performing Organization Report No. TO-2029
7. Author(s) SLADEK, George, SOUKUP, Carol	8. Transport Canada File No. D1455-101-20
9. Performing Organization Name and Address IBI Group 156 Front Street West, 6th Floor Toronto, Ontario M5J 2L6	10. DSS File No. 14SD.T8200-3-3606 11. DSS or Transport Canada Contract No. OSD84-00009
12. Sponsoring Agency Name and Address Transportation Development Centre (TDC) Guy Favreau Complex, Suite 601, West Tower 200 Dorchester Blvd. West Montreal, Quebec H2Z 1X4	13. Type of Report and Period Covered April 1984-March 1985 14. Sponsoring Agency Code TDC 6183
15. Supplementary Notes	16. TDC Project Officer Trevor Smith

17. Abstract

This report presents findings and recommendations for a mobile air terminal to supplement or replace conventional air terminals, particularly at small domestic commuter airports. The concept envisages the modification of a standard highway bus to a vehicle capable of operating on highways and airport aprons. It would contain all facilities required to check in passengers at a downtown street curb, transport them and provide a weatherproof direct connection to the aircraft. Deplaning would occur in a similar reverse fashion. This concept would provide passengers with a level of convenience exceeding any current operating system.

The study established the physical and operating system requirements and demonstrated the concept's technical feasibility including the electronic data and communications systems for computerized passenger and baggage check-in, ticket sales, aircraft load control and vehicle dispatch, which would be assembled with off-the-shelf components. Conversions of the highway bus for side or frontal loading/unloading of passengers were successfully demonstrated. A number of solutions appear practical for on-vehicle baggage check-in and storage.

The concept was designed to service the de Havilland Dash 7 aircraft, but is believed adaptable to most commuter-type aircraft in the 20- to 50-seat range.

18. Key Words	19. Distribution Statement
STOLport, Mobile Air Terminal, Bus, Passenger Transfer Vehicle, Baggage, Computer Reservations, Commuter, Dash 7, Economic, Operations	Limited number of copies available from the Transportation Development Centre

20. Security Classification (of this report)	21. Security Classification (of this page)	22. No. of Pages	23. Price
Unclassified	Unclassified	60	Nil

TDC CDT 79-005

FORMULE DE DOCUMENTATION POUR RAPPORT

1. N° du rapport Transports Canada	2. N° de l'étude — CDT	3. N° de catalogue du destinataire
TP 6429 E	6183	

4. Titre et sous-titre	5. Date du rapport
MOBILE AIR TERMINAL RESEARCH	mars 1985
	6. N° du rapport de l'organisme exécutant: TO-2029

7. Auteur(s)	8. N° de dossier Transports Canada
SLADEK, George, SOUKUP, Carol	D1455-101-20

9. Nom et adresse de l'organisme exécutant	10. N° de dossier — ASC
IBI Group 156 Front Street West, 6th Floor Toronto, Ontario M5J 2L6	14SD.T8200-3-3606
	11. N° de contrat — ASC ou Transports Canada: OSD84-00009

12. Nom et adresse de l'organisme parrain	13. Genre de rapport et période visée
Centre de développement des transports (CDT) Complexe Guy Favreau, Suite 601, tour ouest 200 ouest, boul. Dorchester Montréal, Québec H2Z 1X4	avril 1984 - mars 1985
	14. Code de l'organisme parrain: CDT 6183

15. Remarques additionnelles	16. Agent de projet — CDT
rapport sommaire en français est disponible - TP 5985F	Trevor Smith

17. Résumé

Ce rapport présente les résultats d'une étude concernant les terminus aéroportuaires sur roues pour remplacer ou compléter les aérogares classiques et, plus particulièrement, les petits aéroports régionaux. Le concept envisagé est de transformer un autocar classique en un véhicule apte à évoluer sur l'aire de trafic d'une aérogare tout en maintenant ses qualités routières, et comportant les équipements nécessaires à l'enregistrement des passagers ainsi qu'une passerelle escamotable protégeant ces derniers des intempéries à l'embarquement. L'autocar modifié ferait la navette entre l'aéroport et le centre-ville et offrirait aux passagers une commodité supérieure à tous les systèmes actuels en service.

L'étude définit les caractéristiques physiques et opérationnelles du terminus envisagé et démontre la faisabilité technique du concept et des systèmes informatiques et de communications nécessaires à l'émission automatique des billets, l'enregistrement des passagers et des bagages, le contrôle de la charge de l'avion et à la répartition, le tout à partir d'appareillage présentement disponible sur le marché. Les possibilités de transformer indifféremment l'autocar ordinaire en terminus mobile à passerelle d'embarquement latéral ou frontal ont été démontrées. Diverses solutions semblent pratiques pour la prise en charge et la manutention des bagages.

Quoique l'étude soit axée sur la desserte des DASH 7 de de Havilland, elle pourrait être adaptée à la desserte de la plupart des avions de transport régional de 20 à 50 places.

18. Mots-clés	19. Diffusion
ADACport, terminus aéroportuaire sur roues, autobus, transbordeur, bagages, réservations automatisées, transport régional, Dash 7, économie.	Le CDT dispose d'un nombre limité d'exemplaires.

20. Classification de sécurité (de ce rapport)	21. Classification de sécurité (de cette page)	22. Nombre de pages	23. Prix
non classifié	non classifiée	60	---

CDT/TDC 79-005

ACKNOWLEDGEMENT OF PARTICIPATION

This study (Mobile Air Terminal Research) was conducted on behalf of the Government of Canada, Transportation Development Centre.

Industry support has been generously provided by Prevost Car Inc., Canavia Transit Inc. and The de Havilland Aircraft of Canada Limited.

TABLE OF CONTENTS

		PAGE
1.	INTRODUCTION	1
	1.1 BACKGROUND	1
	1.2 STUDY OBJECTIVES	3
	1.3 PROJECT METHODOLOGY	3
2.	MARKET SURVEY	5
	2.1 OBJECTIVES	5
	2.2 METHODOLOGY	5
	2.3 INCIDENCE OF COMMUTER OPERATIONS	6
	2.4 AIRCRAFT FLEET COMPOSITION	6
	2.5 MOBILE TERMINAL UTILIZATION	8
	2.6 COMMUTER AIRLINE FORECASTS	10
	2.7 CONCLUSIONS	11
3.	OPERATIONAL REQUIREMENTS MOBILE AIR TERMINAL	12
	3.1 INTRODUCTION	12
	3.2 PASSENGER CHECK-IN	12
	3.3 VEHICLE DISPATCH	12
	3.4 VEHICLE LOCATED EQUIPMENT	12
	3.5 OPERATIONS CENTRE	13
	3.6 PASSENGER VEHICLE	13
	3.7 PASSENGER TRANSFER	15
	3.8 BAGGAGE HANDLING	16
	3.9 OTHER CONSIDERATIONS	16
4.	PASSENGER TERMINAL	17
	4.1 METHOD OF COMPARISON	17
	4.2 ENPLANING PASSENGER ACCUMULATION	18
	4.3 SPACE AND SERVICE LEVEL STANDARDS	19
	4.4 CHECK-IN SPACE	20
	4.5 PUBLIC WAITING	21
	4.6 BAGGAGE CLAIM AREA	22
	4.7 DEPARTURE LOUNGE	22
	4.8 SUMMARY OF SPACE REQUIREMENTS	23
5.	USER CONVENIENCE	27
	5.1 ASSUMED USER CHARACTERISTICS	27
	5.2 CONVENIENCE OF ACCESS	27
	5.3 PASSENGER HANDLING	30
	5.4 USER COSTS	32
	5.5 DISADVANTAGES	33
6.	COMMUNICATIONS AND CONTROL EQUIPMENT	34
	6.1 EQUIPMENT AVAILABILITY	34
	6.2 PASSENGER SERVICING	37
	6.3 COMPUTER AIDED DISPATCH (CAD)	40
	6.4 AUTOMATIC VEHICLE LOCATION	40
	6.5 CENTRAL CONTROL	41
	6.6 OPERATING FREQUENCIES	41
7.	VEHICLE CONSIDERATIONS	42
	7.1 STATE OF THE ART	42
	7.2 BASIC VEHICLE SELECTION	43
	7.3 AIRCRAFT LOADING SYSTEM	48
	7.4 PASSENGER ENTRY AND BAGGAGE HANDLING	50
8.	CONCLUSIONS	58
	8.1 MARKET DEMAND	58
	8.2 COMMUNICATIONS AND CONTROL SYSTEM	58
	8.3 VEHICLE CONSIDERATIONS	58
	8.4 ESTIMATED COSTS	60

LIST OF FIGURES

		PAGE
FIGURE 1	MOBILE AIR TERMINAL CONCEPT	2
FIGURE 2	INFORMATION FLOW DIAGRAM	15
FIGURE 3	COMPARISON OF PASSENGER SEQUENCES	31
FIGURE 4	MOBILE COMMUNICATIONS UNIT	35
FIGURE 5	DATAP DISPATCH SYSTEM DIAGRAM	36
FIGURE 6	PASSENGER FLOW DIAGRAM	38
FIGURE 7	MOBILE LOUNGE-ELEVATING CABIN	44
FIGURE 8	MOBILE TERMINAL-ADJUSTABLE RAMP	45
FIGURE 9	AIRCRAFT/BUS INTER-RELATIONSHIP	47
FIGURE 10	FRONT LOADING MECHANISM	50
FIGURE 11	FRONT END EQUIPMENT OPTIONS	51
FIGURE 12	SIDE LOADING OPTION	52
FIGURE 13	BAGGAGE HANDLING-CONTAINER/ELEVATOR CONCEPT	53
FIGURE 14	BAGGAGE HANDLING OPTIONS - 1	54
FIGURE 15	BAGGAGE HANDLING OPTIONS - 2	55
FIGURE 16	BAGGAGE HANDLING -SIDE LOADING CONCEPT	57
FIGURE 17	TYPICAL LAYOUT	59

LIST OF TABLES

		PAGE
TABLE 1	COMMUTER AIRCRAFT IN COMMON SERVICE IN CANADA & U.S.	7
TABLE 2	DISTRIBUTION OF AIRCRAFT TYPE BY CARRIER	7
TABLE 3	MOBILE TERMINAL SALES ESTIMATES - FULL MARKET PENETRATION	9
TABLE 4	TYPICAL AIRCRAFT PASSENGER DOOR DIMENSIONS	14
TABLE 5	DEPARTURE LOUNGE PEAK PASSENGER ACCUMULATION	25
TABLE 6	HOLD ROOM AREA REQUIREMENTS	26
TABLE 7	AIR TERMINAL BUILDING AREA COMPARISON	26
TABLE 8	EVALUATION OF TRIP CATEGORIES	29

1. INTRODUCTION

The Mobile Air Terminal Study documents investigations into the feasibility of converting a standard highway bus into a computer equipped mobile air terminal for checking in passengers and baggage and transferring them directly from a downtown city curb to a waiting aircraft for departure. Similarly, deplaning passengers and baggage would be transported directly from the aircraft to a central downtown curb. The concept is shown in outline form on Figure 1.

1.1 Background

Canavia Transit Inc./City Centre Airways Ltd., intend to introduce commercial Short-Take Off and Landing (STOL) services utilizing de Havilland Dash 7 aircraft, between Toronto Island Airport in Toronto, Rockcliffe Airport in Ottawa and the experimental STOLport in Montreal (Victoria Car Park Site). This service is based upon a Transport Canada sponsored experimental shuttle service between Montreal/Ottawa in 1976. An important feature of the passenger handling system proposed by this carrier is a flight-specific bus or STOLmobile service for transporting passengers directly between city centre locations and the aircraft.

In order to prove the viability of the STOLmobile service to prospective investors, Canavia, in October 1983, and later in January 1984, conducted two demonstrations during which passengers were loaded on to a highway bus at the Royal York Hotel in downtown Toronto, transported to, and loaded directly on to a Dash 7 aircraft at Toronto Island Airport. These demonstrations showed that the boarding operations could be completed within an elapsed time of approximately 20 minutes measured from the time of closing of the bus door at the passenger pick-up point to the closing of the aircraft door. This trip time included travel on Toronto streets, the marine ferry crossing to the airport and the loading of the aircraft.

The reaction of the potential investors to the hassle-free, convenient service provided by the bus led to interest in making the service a permanent feature of commuter STOL operations. It has the potential to provide a high level of service to passengers and it can also reduce requirements for passenger and related facilities at the airport, thereby reducing both capital and operating costs.

Discussions with officials of the Transportation Development Centre raised the possibility that a mobile terminal may have applications beyond STOL, particularly at commuter airports where the air services are provided by single carriers operating small aircraft. It could also have application in cases where the airport was located at a considerable distance from a concentrated load centre or at larger centres where it might provide a service superior to that available from existing limousine services. It was these considerations which formed the basis for this research project.

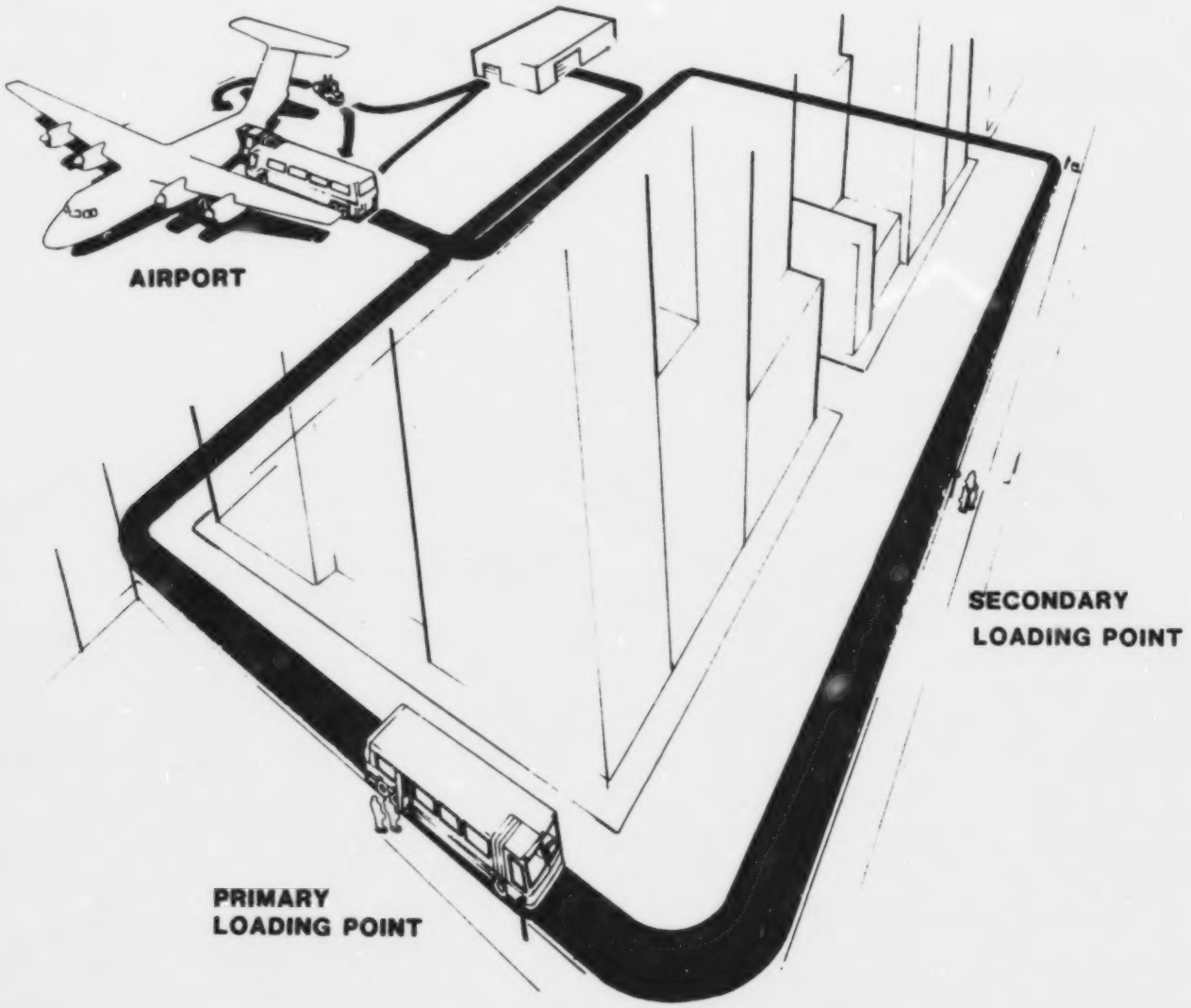


Figure 1 MOBILE AIR TERMINAL CONCEPT

1.2 Study Objectives

The main objective of this research project was to produce a conceptual design for a ground vehicle incorporating a standard road bus chassis which would allow passenger processing to be carried out on board, and would be capable of transporting passengers directly between off-airport locations and the aircraft. The vehicle would have to be capable of being licensed to travel on the public road system. It would also require communication equipment for checking-in confirmed passengers, recording standby passenger information and selling tickets. Mechanical features of the vehicle should include a device for coupling directly with the aircraft to allow sheltered transfer of passengers; a baggage system which would be substantially error-free for handling both enplaning and deplaning baggage; a communications and dispatch system which would allow the movements of the vehicle to be co-ordinated with flight schedules, to enhance the on-time performance of both the vehicle and the aircraft.

Another objective was a market study to examine such factors as the range and capacity of aircraft that might be served; ease of achieving a direct vehicle-to-aircraft connection for the various aircraft types in commuter service; and the number and locations of carriers operating aircraft having between 20 to 50 seats. A 20 seat aircraft would require the smallest terminal which would likely be commercially viable. The 50 seat aircraft is probably the largest size for which passenger security screening requirements might be waived on Canadian domestic routes. Security screening on mobile vehicles, while possible, would significantly reduce the practicability of the concept.

1.3 Project Methodology

The methodology employed to achieve the objectives of the research project was as follows:

a. A survey was conducted identifying air carriers in Canada and United States operating aircraft in 19 to 60 seat range. These were categorized by geographic location, total fleet size and aircraft types.

b. Manufacturers' literature was reviewed to determine the state of the art and availability of apron passenger transfer vehicles.

c. A number of manufacturers of standard buses were interviewed to determine the practicability of converting their equipment into mobile air terminals.

d. Manufacturers of mobile communications and dispatch equipment were also interviewed to determine the availability of suitable off-the-shelf components.

e. A system specification for the intended service was prepared.

f. Three alternative vehicle-to-aircraft docking arrangements were examined. The practicability of making the necessary modifications to a standard highway bus was assessed by the sub-consultants, GSM Design Incorporated, and Prevost Car Inc. The latter firm is a leading Canadian bus manufacturing company and an industrial supporter of the project.

g. The concept was reviewed by the de Havilland Aircraft of Canada Limited with emphasis on the physical connection between the mobile terminal and the aircraft.

h. Cost information was obtained from industry sources for both the electronic equipment and the mobile terminal vehicle.

2. MARKET SURVEY

The survey of the market potential for the mobile terminal was based on air carrier operations data and on air carrier fleet statistics contained in commercial aviation journals including Canadian Aviation, Flight International, and Interavia. Forecast information on air commuter operations was obtained from F.A.A. Aviation Forecasts - FAA - APO - 84-1 February 1984. Aircraft design information was obtained from Janes Commercial Transport Aircraft; design information on the Dash 7, Dash 8 and Twin Otter aircraft was obtained directly from the de Havilland Aircraft of Canada Limited.

2.1 Objectives

The objectives of the marketing study were to determine the theoretical upper limit of potential demand for mobile air terminals in Canada and in the United States and to determine the range of desirable capacities and features which might be relevant to domestic commuter air operations. The market-related factors assessed included:

- the names and numbers of commuter airlines that might use the vehicle
- their location
- their route structure
- their fleet mix
- the number of buses necessary to serve the various sizes of fleets
- desirable special features of mobile terminals.

2.2 Methodology

The theoretical market potential for the vehicle was determined by:

a. The various types of commuter aircraft in service in Canada and the United States, within the 19 - 60 seating capacity seat range were identified. This information was obtained from Flight International and de Havilland Aircraft of Canada Limited.

b. Relevant air carriers in Canada and USA were categorized in terms of location, route structure, and fleet composition.

Climatic factors affecting passenger transfer operations, and potential heavy use of the service by non-business travellers (e.g. tourists to Las Vegas) were assessed judgmentally.

c. Fleet mix characteristics data including aircraft distribution by size by carrier was used to determine likely bus capacity requirements and bus fleet sizes.

d. Typical airline operating scenarios were developed to enable quantification of likely mobile terminal demand.

e. Summary forecast trends for commuter operations were examined to provide an overview of the industry.

2.3 Incidence of Commuter Operations

Twenty-seven Canadian and 48 American carriers were found to operate commuter aircraft within the selected capacity range of 19 to 60 seats. These carriers were widely spread geographically in both countries. All Canadian carriers, including operators of the smaller Otter and Beaver aircraft (seating capacity less than 19) were located in areas having demanding climatic conditions and at those 23 carriers operated in regions experiencing harsh weather, such as in the Arctic. In the United States, the number of carriers operating under similar climatic conditions were 27 and six respectively.

Such commuter operations charactistically transport business people although three operations in Canada and seven in the United States appear to carry a high proportion of non-business passengers because they serve tourist resorts primarily. Between five and ten of the American carriers in the sun belt states may handle a large percentage of aged passengers. These factors might warrant consideration of special handling features on the vehicle for the physically handicapped.

2.4 Aircraft Fleet Composition

Eleven types of commercial aircraft (with seating capacities between 19 and 60 seats) are in commuter service in Canada and 21 types are in service in the United States. These aircraft, identified by manufacturer, are listed in Table 1. The most popular aircraft in North America within this range is the de Havilland Twin Otter. Two, highly popular but smaller aircraft, (199 in service) were the de Havilland DHC-2 Beaver and the DHC-3 Otter. These latter aircraft are probably too small to warrant mobile terminal operations. Carriers operating them are however, possible candidates for trading up to larger aircraft such as the Twin Otter or the Dash 8, as their commuter market expanded.

Table 2 shows the distribution of aircraft by size and carrier. For example, 236 twenty-seat passenger aircraft were operated by 63 carriers for an average of four aircraft per carrier.

Aircraft	Passenger Capacity	Number of Aircraft in Operation U.S.* (1984)	Canada (1983)
Beech 99	15	113	-
Jetstream	19	18	-
CASA 212	28	27	-
Convair 440/580/600	44-50	94	17
de Havilland Twin Otter	19	108	85
de Havilland Dash 7	50	37	5
Douglas DC3/4/6/C47	28	37	60
Embraer Bandeirante	18	103	-
Fairchild F-27/F-227	46	24	5
Fairchild Metro/ Expediter	19	174	4
Fokker F27	50	15	-
Gulfstream G1/G1-C	37	8	-
Hawker Siddley HS748	58	-	23
Martin 404	44	11	-
Mohawk 298	25	4	-
NAMC YS11	52	26	1
Nord 262	27	11	-
Saunders ST27	23	-	7
Shorts 330	30	50	1
Shorts 360	36	23	-
Vickors Viscount	-	-	1
Totals		883	209

Table 1 Commuter Aircraft in Common Service in Canada and U.S.

*Includes aircraft fully dedicated to cargo.

No. of Aircraft By Size Per Carrier Fleet	No. of Carriers Using Aircraft of Each Size (Seats) 20	22	26	30	33	34	36	48	54	56	58
1	4	1	1					2			1
	9*										1*
2	10		2	2	3	2				2	
	6*										
3	8				1			2	1*		1*
	2*										
4	5	2			2		2				
5	5		1	2	1	1					
6	5										
7	1*								1		
8	1*							1*			
9	1								1		
10	2								1		
11	1										
12	1*										1*
16	1										

Table 2 Distribution of Aircraft Type by Carrier

* Canadian Operations

The majority of the carriers in the sample operated aircraft having approximately 20 seats and had fleets of three aircraft or less, indicative of low volume operations.

Only eight carriers had a fleet size in the order of more than seven aircraft. In the 22 to 34 seat range, 21 carriers operated a total of 60 aircraft for an average of three aircraft per fleet. In the 36 to 60 seat range, 15 carriers operated 72 aircraft (total) or approximately five per fleet.

Thirty-nine carriers operated four or more aircraft of a given size while 58 operated three or less. Thirteen carriers operated more than four aircraft having a capacity of 30 seats or more per aircraft.

Twenty-three carriers operating aircraft having less than 20 seats have fleets ranging in size from four to 16 aircraft. Some of these carriers are candidates for trading up to larger aircraft as the economy improves.

In the 30 to 60 seat range, nine operators had two aircraft and five had three. The operations of these carriers might benefit from new technology such as the mobile terminal concept.

2.5 Mobile Terminal Utilization

Table 3 illustrates the estimated numbers of buses required to serve the fleet mix shown on Table 2. Potential sales projections based on order of magnitude vehicle unit costs and 100 percent market penetration are also shown.

Vehicle requirements were calculated as a range because actual carrier schedules which are a major determining factor were not available. It was assumed that carriers operating multi-based shuttle services requiring rapid aircraft turnaround times would be more likely to purchase a full complement of buses than those operating long haul services where airport turnaround times might be less critical. The ratio of mobile terminal requirements to aircraft decreases for the larger fleets since vehicle optimization is usually easier to achieve for large systems than for small ones.

The following mobile terminal requirements were estimated for short haul shuttle and long haul flights:

No. of Aircraft in Fleet	Type of Service	Vehicles Required at each Airport
1	shuttle operation	2
1	long haul	1 - 2
2	shuttle operation	3
2	long haul	2
3	shuttle operation	4
3	long haul	2

Vehicle Size			Potential Sales			
Aircraft Capacity (Passengers)	Passengers Per Flight (0.8 L.F.)	Bus Capacity (Passengers*)	No. of Carriers	Estimated No. of Vehicles	Estimated Cost Cost Per Unit** ($CDN X 1000)	Total Market ($CDN X 1000)
20 - 22	16	10	68	215-299	15 passenger bus ($75. + $30.)	22,575. 31,395.
26	21	13	4	13- 17	15 passenger bus ($75. + $30.)	1,365. 3,570.
30 - 36	24 - 29	14 - 17	18	40- 62	20 passenger bus ($120. + $40.)	6,400. 9,920.
48	38	29	5	13- 21	30 passenger bus ($160. + $50.)	2,730. 4,410.
54 - 56	43 - 44	32 - 34	6	18- 28	35 passenger bus ($180. + $60.)	4,320. 6,720.
60	48	36	4	9- 15	44 passenger bus ($200. + $70.)	2,430. 4,050.
TOTALS				308-442		39,820. 60,650.

Table 3 Mobile Terminal Sales Estimates
Full Market Penetration

* Assumes 60% of Air Passengers Would Use Vehicle.
**Vehicle Cost and Modification Cost.

It was assumed that mobile terminal requirements would not exceed four units at any airport regardless of aircraft fleet size.

A mature Toronto/Montreal/Ottawa STOL service involving three airports would require 11 to 13 vehicles (including spares) for a three-airport shuttle operation.

2.6 Commuter Airline Forecasts[1]

FAA forecasts of growth trends for commuter operations indicate renewed optimism for the U.S. following recovery from the recent recession and because of deregulation. After a slowdown in the early 1980's, a gradual upswing greater than that in other segments of the aviation industry is in progress for the commuter sector.

In the United States, 1984 passengers enplanements are expected to be 10.3 percent higher than in 1983, with further increases of 8.8 and 8.1 percent to occur in 1985 and 1986 respectively. The average annual growth rate between 1983 and 1995 in the commuter sector is expected to be slightly lower at 7.4 percent as compared to 5 percent for all sectors combined. During this period the number of commuter enplanements are expected to double and revenue passenger miles are expected to triple. This is a favourable market outlook for the aviation sector most likely to benefit from mobile lounges. A further positive aspect of this air commuter growth trend is the forecast for increased use of larger aircraft.

Aircraft having up to 15 seats continue to dominate in the U.S. commuter sector but their relative market share is expected to drop from 46.5 to 36.1 percent by 1995. The proportion of aircraft in the 15 to 19 seat category is also expected to decline from 33 percent to 28.6 percent of the total fleet, although the numbers of aircraft in both size ranges are forecast to increase at an annual average of 2.5 and 3.2 percent respectively.

The number of commuter aircraft in the 20 - 40 passenger capacity and in the over 40 passenger seat categories are expected to grow by 11.5 and 7.5 percent respectively, taking an additional 10 and 5 percent of the total passenger market respectively.

The trend in potential sales and utilization of mobile lounge vehicles is linked to the increase in the numbers of larger aircraft.

---

1. American statistics are cited here due to their greater currency and the greater relative importance of the U.S. airline commuter market to Canada's in the context of this study.

The most promising vehicle in terms of theoretical sales appears to be a 10 to 15 seat bus (Table 3). Sales estimates assuming simplified electronic systems and minimal mechanical connections are in the order of $22,500,000 to $31,400,000, assuming 100 percent market penetration. However, actual sales would be very much lower as the buses would represent disaproportionate capital and operating costs outlays for the small scale air carrier operators generally involved.

Less potential demand exists for the larger capacity vehicles. However, with the anticipated trend towards "trading up" to larger aircraft greater demand is possible. The operators of aircraft in the 30 to 50 seat range are more likely to benefit from the concept and therefore attention should initially be focussed on the requirements of this group.

2.7 Conclusions

Preliminary investigations indicate a significant theoretical market for mobile air terminals in the U.S., and a similar but more limited market in Canada. This market is dependent upon a number of factors such as the waiving by regulatory agencies of the mandatory security screening of passengers on domestic aircraft having 50 seats (or less). This would allow shuttling of passengers directly to the aircraft and bypassing of the airport passenger terminal building.

There appears to be scope for the use of mobile terminals in specialized applications such as for the transportation of charter groups, of aged or handicapped passengers or of passengers destined to a single location such as a resort. Mobile units could also be used as decentralized "sterile lounges" for domestic security processing or for customs and immigration inspections on demand at transborder locations, where the installation of permanent inspection and control facilities is not practical.

The most promising initial market would result from implementation of the Toronto/Montreal/Ottawa STOL service. Eleven to thirteen buses in the 35 to 50 passenger capacity range could be required by the late 1980's. This would represent the largest market in terms of volume sales, but it would facilitate initial market penetration and would provide the basis for further development of the vehicle and its operating systems.

3. OPERATIONAL REQUIREMENTS MOBILE AIR TERMINAL

Operating and physical specifications for the mobile terminal were based on the assumption that air operations capable of benefiting from the full capability of the system existed. The concept is flexible and can be scaled down in terms of both vehicle size and system sophistication in order to meet the lesser requirements of specific operators.

3.1 Introduction

Outline specifications for a fully developed mobile air terminal took into account four essential functions:

1. Direct passenger check-in and drop-off at city curb locations;

2. Passenger transfer between the pick-up point and the aircraft;

3. Sheltered passenger transfer between the aircraft and the vehicle; and

4. Baggage handling for enplaning and deplaning passengers.

3.2 Passenger Check-In

The vehicle is required to accommodate the following check-in functions:

- confirmation of reservations;
- boarding pass issue;
- stand-by passenger control;
- ticket sales;
- baggage check; and
- collection and transmission of ticket sales information and other passenger and performance related data.

3.3 Vehicle Dispatch

A computerized vehicle dispatch system is required. This system should include a direct or indirect voice link with the aircraft for transmitting delay and flight status information. The voice link could provide direct radio communication with the aircraft or messages could be relayed by airlines flight operations centre.

3.4 Vehicle Located Equipment

The following equipment requirements for the mobile terminal were identified:

- a computer terminal including keyboard and monitor

- a combined voice and data radio link including channel controller;
- a ticket and/or boarding pass printer; and
- credit card reader connected to the data transmission link.

The system should on average allow complete passenger check-in to be accomplished within 30 seconds per passenger, including baggage check-in. Ticket sale and passenger check-in should be achievable in 45 seconds.

3.5 Operations Centre

The service would be capable of being controlled from a single location at each airport. The control centre could be equipped with the following:

- a host computer which would be linked to the main operations and reservations computer of the airline;

- a voice and data communications facility to interface with the complementary mobile terminal located equipment; and

- a mobile terminal dispatch unit which would also have a direct or indirect communications link with the aircraft, the airport and passenger aircraft parking apron operations.

A schematic diagram showing a conceptual arrangement of the proposed system is shown on Figure 2.

3.6 Passenger Vehicle

The mobile terminal should incorporate either a city bus or a highway-type bus chassis. The vehicle would accommodate the following functions:

1. A passenger check-in area with space for an attendant, a check-in computer terminal, a ticket writer and baggage storage space.

2. Passenger seating for a minimum of 30 passengers. This seating could be arranged as for highway buses or preferrably laid out around the vehicle periphery to facilitate the handling of carry-on baggage.

3. A driver's position equipped with a radio transmitter and receiver for vehicle dispatch and control.

4. Segregrated areas for passengers already checked in and those awaiting processing.

5. A mechanism for directly connecting with the aircraft for passenger transfer.

6. Baggage storage and handling capability.

The vehicle should be capable of being licensed to operate on public roads at operating speeds of up to 60 kilometres per hour on urban roads and up to 80 kilometres on high-speed routes.

3.7 Passenger Transfer

The physical connection for providing direct and sheltered transfer of passengers between vehicle and the aircraft should be as direct as possible. Any change of levels should be accommodated by a ramp rather than stairs. Typical passenger door dimensions for a range of aircraft are shown in Table 4.

Aircraft Type		Door Dimensions (Inches)		
Manufacturer	Model	Sill Elev.	Height	Width
AEROSPATIALE	ATR-42	50	69	29.5
BAE	HS748	72	62	32
BOEING	Chinook Helicopter	31	65	35
CANADAIR	Challenger	54	70	36
DeHAVILLAND	Dash 7	47	69	30
	Dash 8	47	66	30
DORNIER	228-10	33	50	33
EMBRAREO	EMB-12C	57	63	28
FOKKER	F27	42	65	29
SAAB	34C	64	65	28
SHORT	330	37	56.5	27
	360	37	56.5	27
SWEARINGER	METRO III	N.A.	53	25

Table 4 Typical Aircraft Passenger Door Dimensions

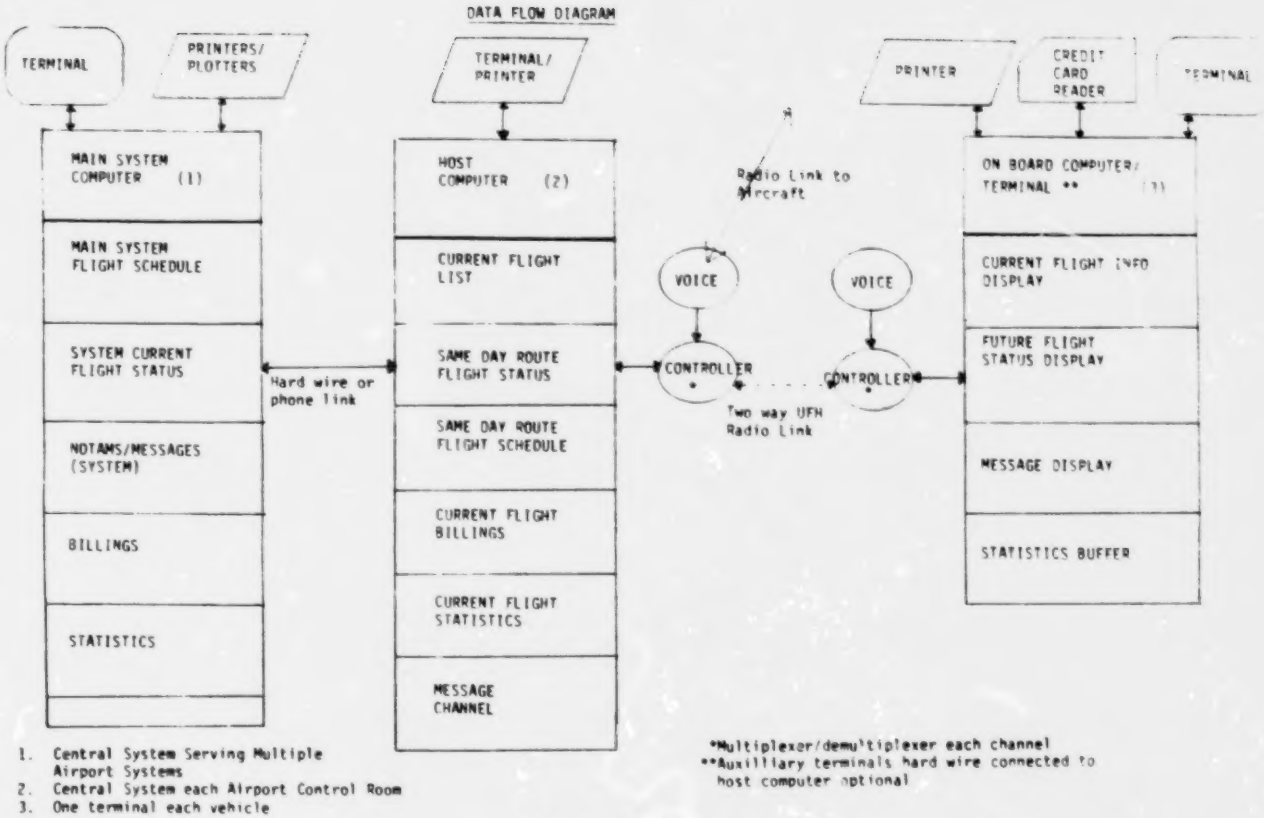


Figure 2 INFORMATION FLOW DIAGRAM

The connecting mechanism should be designed to allow the aircraft to remain in full view of the driver during the coupling process. Otherwise a television camera should be provided for guidance purposes. The connection should be of simple construction and either manually or a hydraulically operated. It should provide substantially full protection against rainfall but need not be airtight. It should not interfere with the visibility of the driver when driving. The vehicle must be capable of meeting all highway safety standards and should be capable of interfacing with the aircraft without modification of the aircraft's structure or door.

The time required to manoeuvre the vehicle into position, to complete the connection between it and the aircraft and for the first passenger to pass the aircraft door should not exceed two minutes.

3.8 Baggage Handling

The mobile terminal shall be capable of accommodating the baggage of both enplaning and deplaning passengers. A standard vehicle load of 30 passengers, would produce approximately 12 pieces of checked baggage on average. At an upper limit, the vehicle should be capable of accommodating 20 pieces of checked baggage. The preferred method of baggage storage would be in a compartment accessible from the outside of the mobile terminal so as not to interfere with passenger loading or unloading.

3.9 Other Considerations

The concept should be developed for the Dash 7 STOL aircraft, however, its application to other aircraft of a similar size should also be considered. The initial application of this system could involve passenger loads of approximately 30 people, but the concept should also be applicable to smaller capacity aircraft or to smaller passenger loads on larger aircraft. Full aircraft passenger loads of up to 54 passengers may have to be handled as an upper limit.

While the concept as defined is a comprehensive system, optional solutions having reduced capability should also be considered. Features which might be considered optional include:

- direct mechanical connection to the aircraft;
- mechanized baggage handling;
- ground to air communications;
- central dispatch; and
- automatic vehicle location.

4. PASSENGER TERMINAL

Two major benefits foreseen for the mobile air terminal are a possible reduction in fixed passenger terminal facilities and an improvement in passenger level of service. The effect of the concept on fixed airport facilities is assessed in this chapter and its effects on user convenience are assessed in Chapter 5.

4.1 Method of Comparison

The mobile terminal could reduce the requirements for or possibly eliminate the need for a passenger terminal building at the airport. In order to quantify its effect on airport facilities, three operating options were studied:

1. a conventional airport system;

2. a STOLmobile system as developed during the Air Transit Demonstration project but with check-in facilities also available at a downtown terminal; and

3. a mobile air terminal system.

Passenger holding areas at conventional air terminals usually accommodate the following activities:

- Ticket sales
- Passenger and baggage check-in
- Security screening
- Passenger pre-boarding
- Deplaning passengers baggage pick-up
- Well-wisher waiting
- Greeter waiting
- Delayed passenger waiting
- Visitor waiting
- Commercial concessions

The space required for each of these activities is a function of the associated peak person accumulation and the floor area to be provided for each occupant. The unit space allocation will vary with the severity, frequency and duration of the peak demand. The most severe loading will occur when flights are delayed during peak periods thereby superimposing their passengers on normal peak hour loads.

Therefore, two conditions were examined:

1. Peak space requirements under the "no delay condition" when normal space standards would apply (Transport Canada Level C).

2. Peak space requirements under "delay" conditions where some crowding might be acceptable (Level D for delays up to 15 minutes).

The normal operating condition assumed for this study was that a minimum of two air routes would be served from each STOLport in the system. Under normal conditions two flights would be scheduled to depart within a 15 minute period. A third flight would be scheduled to depart 60 minutes after the first departure. This corresponds to the proposed CANAVIA schedule for Toronto and Montreal STOLports.

Mechanical, and to a lesser extent weather delays are unpredictable in duration or time of occurrence. With two flights scheduled to depart within a 15 minute period, a 15 minute or greater delay of the first aircraft would result in the accumulation of two enplaning loads in the terminal. This condition is highly likely and will be referred to as a "moderate delay". Severe weather conditions, unlike mechanical problems, can delay the movement of all aircraft; for the assumed system, a one hour weather delay could delay three departures. Passenger accumulation beyond this level would not likely occur since under more severe delay conditions passengers would leave the terminal either to return later or would cancel their trips. Delays between 15 minutes and one hour were considered to be "severe delays".

Passenger space requirements are also a function of the mode of transportation that passengers use to arrive at the airport. At a conventional metropolitan airport as much as 85 percent of short-haul domestic passengers would use automobiles, either private car or taxi. The remainder would use buses or courtesy limousines provided by hotels. If STOLmobiles or mobile terminals were made available, automobile usage would be very much lower. To demonstrate the effect of modal preference on facilities requirements three access options were compared:

Case (1): A conventional operation where approximately 85% of passengers would arrive by automobile and the remainder by public transport or courtesy limousines.

Case (2): A free, carrier-operated flight specific STOLmobile service transporting passengers between the central business district (CBD) and the airport air terminal (Transport Canada Airtransit Situation).

Case (3): A free, carrier-operated flight specific mobile air terminal transferring passengers directly between downtown and the aircraft (The Mobile Terminal Concept).

4.2 Enplaning Passenger Accumulation

The following modal preferences and flow patterns were assumed for departing passengers:

For Case (1) - passengers would begin to arrive at the air terminal 40 minutes before flight departure time; 50 percent of all of the passengers would be in the terminal 15 minutes before flight time; 90 percent of the passengers would be in the departure lounge ten minutes before departure time. Aircraft boarding would commence ten minutes before departure time to allow for walking to and boarding the aircraft.

Peak passenger accumulation was assumed to be 100 percent of the first flight plus 50 percent of the second flight (scheduled to depart 15 minutes later than the first). Each aircraft would to have 54 seats and the average peak hour aircraft load factor was assumed to be 80 percent.

For Case (2) - passengers proceeding directly to the air terminal by automobile would behave in the same manner as in Case (1). Since the STOLmobile would be flight specific, its scheduled arrival time could be delayed to ten minutes before flight departure time. Passengers and baggage would be checked in at the downtown terminal so that standing room only would be required at the airport for STOLmobile passengers under normal conditions. Under severe delay conditions no more than two vehicles would be dispatched to the airport to provide "ready loads" for departures. Other delayed passengers would wait in the city.

For Case (3) - only those passengers arriving at the airport by automobile or public transport would normally require air terminal space; passengers arriving by mobile air terminal would be loaded directly onto the aircraft. Under the moderate delay condition (up to 15 minutes) passengers would wait in the mobile terminal. During "severe delays" accommodation would be provided in a suitable building on or near the airport. Second and third vehicles in the peak hour loading sequence would remain in the CBD until the delayed conditions at the airport were cleared.

4.3 Space and Service Level Standards

For a given accumulation, the space required in the terminal building is a function of the total number of people seated and standing. Seated persons require approximately 80 percent more space individually than do standees. The following level of service standards were assumed to apply:

Delay Condition	Level of Service*	Space Per Person (m^2) Seated	Standing
Normal Conditions	A	1.8	no standing
Moderate Delay	D	1.8	0.8
Severe Delay	C	1.8	1.0

*Corresponds to Transport Canada Definitions.

The proportion of passengers to be seated is a function of the length of time they are likely to remain in the building. Estimates were based on the following assumptions:

Normal Operating and Moderate Delay Conditions

The percentage of passengers assumed to be seated under different operating conditions were as follows:

a. Conventional Terminal Option (Case 1):

Under normal conditions seating would be provided for all the passengers on the first departing flight in the peak period plus for one half of the passengers on the second.

Under moderate delay conditions standing room would be provided for the remaining 50 percent of passengers on the second aircraft.

b. STOLmobile Option (Case 2):

Under normal conditions seating would be provided for those passengers arriving by automobile as for Case 1. Standing room only would be provided for passengers arriving by STOLmobile.

Under moderate delay conditions, additional standing room would be provided for delayed passenger arriving by automobile or public transport as for Case 1.

c. Mobile Air Terminal Option (Case 3):

No facilities would be required since all passengers would remain on the vehicle under both normal operating and moderate delay conditions.

Severe Delay

Seating would be provided in accordance with normal operating demand. Additional passengers accumulating in the terminal as a result of severe delays would remain standing under all options.

4.4 Check-In Space

It is estimated that approximately 40 percent of the air passengers will have checked baggage. Passengers arriving by STOLmobile or mobile air terminal will check their baggage either at a downtown terminal or on the vehicle.

Space Requirements for check-in are estimated at:

	Single Position	Double Position
Airline Staff	6.0	8
Check-in Booth	3.0	6
Passenger Standing	3.0	6
TOTAL AREA (m^2)	12.0	20

For the conventional terminal accommodating two departures within 15 minutes, two check-in positions would be required since all departing passengers would be processed at the airport. For the STOLmobile and mobile air terminal options only those passengers providing their own transportation to the airport would require check-in facilities. Up to 50 percent of peak hour departing passengers could be accommodated at a single position (12 sq. m floor area). This provision should be adequate for both STOLmobile and mobile terminal operations.

4.5 Public Waiting

At Lester B. Pearson International Airport (Toronto) the average short haul departing passenger is accompanied by 0.11 well-wishers and the average arriving passenger is met by 0.24 persons (85 percent automobile usage). For normal shuttle commuter operations, the scheduled elapsed time between arriving aircraft would allow the greeters from one flight to leave the terminal before the arrival of those meeting the second flight. (The greeter accumulation would be greatest during the returning resident peak period in the afternoon. Well-wisher volumes are likely to be greatest during the resident passenger departure peak period in the morning.)

The peak visitor accumulation would likely occur when visitors associated with a single arrival partially overlapped with those associated with a single departure. The average visitor to passenger ratio is estimated at 0.15 visitors per peak hour passenger for conventional systems.

Application of this factor shows that a maximum accommodation of 16 visitors assuming 15 minutes between the arrival and departure of two 54 seat aircraft each having an 80 percent load factor. This figure is probably high for city centre based services with a high proportion of business travellers.

The number of visitors will be proportionate to the degree of automobile usage since visitors would not be permitted on either the STOLmobile or mobile air terminal. Therefore, the public waiting area estimates for all three systems reflect assumed levels of automobile usage. Waiting room estimates were based on the following assumptions:

Aircraft size	-	54 seats
Load factor	-	80%
Building space standard	-	75% seated at 1.8 m^2 per person 25% standing at 1.0 m^2 per person

The following public waiting space would be required assuming one arriving and one departing aircraft within a 15 minute period and automobile useage ranging from 0 to 100 percent:

Automobile Usage %	Visitor Factor	Person Accumulation Seated	Standing	Total	Total Space Required (m^2)
100	0.18	12	4	16	26
80	0.14	10	3	13	21
60	0.11	8	2	10	16
40	0.07	4	2	6	9
20	0.04	3	1	4	6
0	0	0	0	0	0

4.6 Baggage Claim Area

Approximately 40 percent of passengers or 18 persons on average on each peak period arriving flight would claim checked baggage. No mechanical baggage claim equipment need be provided as the low numbers of bags can be satisfactorily claimed directly from delivery carts parked either in the terminal or preferrably under a canopy along the departure curb. Waiting space in the amount of 1.0 m^2 per deplaning passenger should be provided for 40 percent of the arriving passengers on a single flight.

STOLmobile usage will reduce this latter requirement since baggage could be loaded directly onto the vehicle and users could bypass or proceed directly through the terminal. With a mobile air terminal both passengers and baggage would be transferred directly to the vehicle from the aircraft. Therefore, deplaning waiting space would be required for only those passengers not using either the STOLmobile or the mobile terminal. The range of deplaning space that would be required is as follows:

	Automobile Usage (Percent)					
	100	80	60	40	20	0
Deplaning Waiting Area (m^2)	18	14	11	7	4	0

4.7 Departures Lounge

A conventional departures lounge would be required at the airport terminal with both the conventional and STOLmobile system options. The area requirements for the two cases would vary since with the conventional terminal seating would normally be provided for all

passengers whereas for STOLmobile passengers, standing room only would be required because of the short passenger dwell times that would normally be involved.

Air terminal hold room space would normally not be required for passengers using the mobile terminal as they would be held on board during moderate delays. Terminal space would be required to accommodate one vehicle load of passengers during severe delay conditions.

Passenger accumulation in the airport terminal would be a function of car usage and airline on time performance. Estimates of standing and seating passenger accumulation for all three options are shown for a range of automobile utilization are shown on Table 5. Hold room area requirements corresponding to these estimates are shown on Table 6.

4.8 Summary of Space Requirements

Passenger related space requirements at on-airport terminals are summarized for the three system options under normal, moderate delay and severe delay operating conditions assuming Dash 7 aircraft operations at 80 per cent load factor.

A. Conventional Terminal

Case 1 - Normal Operations

Normally all passengers would proceed directly to the airport terminal building which would be required to accommodate two departures and one arrival during the peak half hour under Service Level A. Peak departure lounge accumulation would be 63 passengers (1.5 aircraft loads).

	Area (m^2)
Check-In (2 positions)	20
Departure Lounge (100 per cent seated)	113
Public Waiting	26
Deplaning	18
TOTAL PASSENGER RELATED SPACE	177

Case 2 - Moderate Delay

Under this condition two departing aircraft loads must be accommodated simultaneously in the departure lounge under Transport Canada Level of Service D.

		Area (m^2)
Check-In (2 positions)		20
Departure Lounge:		
Seated (63 persons)	113	
Standing (22 persons)	18	131
Public Waiting		26
Deplaning		18
TOTAL PASSENGER RELATED		195

Case 3 - Severe Delay

Under this condition three departing aircraft loads must be accommodated in the terminal simultaneously under Transport Canada Level of Service C.

		Area (m^2)
Check-In (2 positions)		20
Departure Lounge:		
Seated (63 persons)	113	
Standing (67 persons)	67	180
Public Waiting		26
Deplaning		18
TOTAL PASSENGER RELATED		244

B. STOLmobile and Mobile Air Terminals

The space requirements for the airport terminal will depend upon whether use of the STOLmobile or mobile air terminal is to be voluntary or mandatory. If usage was to be voluntary, approximately 40 to 60 percent of all passengers might use it (Interpretation of Transport Canada Airtransit experience). The area requirements for both vehicle options for a range of operating delay conditions and private vehicle usage are shown in Table 7.

Maximum interior space requirements would occur during periods of low mobile lounge usage combined with severe aircraft operating delays. The airport terminal building requirements for severe delay conditions are estimated as follows:

	Airport Terminal Area (m^2)	
	STOLmobile System	Mobile Terminal System
Voluntary Use:		
40 percent	190	172
60 percent	153	126
Mandatory Use:		
100 percent	85	43

System	Delay Condition	Service Level	Percent of Passengers by Automobile 100	80	60	40	20	0
Conventional Terminal	Normal Operating	Seating	63	-	-	-	-	-
		Standing	0	-	-	-	-	-
	Moderate Delay	Seating	63	-	-	-	-	-
		Standing	22	-	-	-	-	-
	Severe Delay	Seating	63	-	-	-	-	-
		Standing	67	-	-	-	-	-
STOLmobile Access	Normal Operating	Seated	63	50	37	25	13	0
		Standing	0	9	17	26	34	43
	Moderate Delay	Seated	63	50	37	25	13	0
		Standing	22	28	32	35	39	43
	Severe Delay	Seated	63	50	37	25	13	0
		Standing	67	71	76	79	83	85
Mobile Terminal	Normal Operating	Seated	63	50	37	25	13	0
		Standing	0	0	0	0	0	0
	Moderate Delay	Seated	63	50	37	25	13	0
		Standing	22	18	14	9	4	0
	Severe Delay	Seated	63	50	37	25	13	0
		Standing	67	63	58	52	47	43

Table 5

Departure Lounge
Peak Passenger Accumulation

Delay Condition	System	Percentage of Passenger by Automobile 100	80	60	40	20	0
Normal Operating	Conventional	113	NA	NA	NA	NA	NA
	STOLmobile	113	99	84	71	57	43
	Mobile Air Terminal	113	90	57	45	23	0
Moderate Delay	Conventional	131	NA	NA	NA	NA	NA
	STOLmobile	131	118	99	80	63	43
	Mobile Air Terminal	131	104	68	52	26	0
Severe Delay	Conventional	180	NA	NA	NA	NA	NA
	STOLmobile	180	161	143	124	106	85
	Mobile Air Terminal	180	153	125	97	70	43

Table 6 Hold Room Area Requirements (m^2)

% Transfer Vehicle Utilization	Terminal Building Area (m^2) STOLmobile Normal Oper.	STOLmobile Moderate Delay	STOLmobile Severe Delay	Mobile Air Terminal Normal Oper.	Mobile Air Terminal Moderate Delay	Mobile Air Terminal Severe Delay
0*	177	195	244	177	195	244
20	154	173	216	145	159	208
40	131	146	190	104	115	172
60	110	109	153	74	81	126
80	79	82	128	45	48	92
100	43	43	85	0	0	43

Table 7 Air Terminal Building Area Comparison

*Corresponds to Conventional Terminal Operations.

5. USER CONVENIENCE

It would be unrealistic to assume that any groundside passenger transfer system can provide an equally high level of service to all air passengers. Therefore in assessing the viability of the mobile air terminal concept, two questions that were assessed and answered are:

1. Can this system provide a better level of service to those passengers for whom it is intended than is existing or likely to be available?

2. Are there enough potential users of the system who would benefit sufficiently to justify the additional cost involved in its operation?

The following section addresses the first question and Chapter 7 addresses the second.

5.1 Assumed Users

The mobile air terminal concept is being primarily proposed as the landside component of an intra-city shuttle commuter air service by small aircraft (less than 60 seats) operating from small inner-city airports. The typical user of this commuter service would be a businessperson travelling from the central business district (CBD) of one city to the CBD of another city or at least starting or terminating his trip in the CBD of one of the cities on his route.

Other possible applications of the system include the transfer of affinity groups such as group charter passengers, travellers to a common resort or centre, handicapped persons requiring special assistance and VIP travellers. The concept could also be used as a sterile lounge for handling special security or immigration cases, special customs and security inspections and to provide low cost access from communities located at considerable distances from airports.

5.2 Convenience of Access

The concept is intended to facilitate business travel. In most major cities, there are high concentrations of business, commercial and professional employment within the city core. A number of cities including the three Canadian centres mentioned previously, also have high quality residential areas either within their cores or on their immediate periphery which could generate significant volumes of non-business related air trips.

For the mobile terminal to be successful, it must provide a good level of service to departing resident travellers since they have more choices available and therefore can be more selective.

Most persons employed in the CBD already have good transportation facilities available to them for work trips either in the form of convenient automobile parking, rapid rail, bus transit or commuter rail. For many persons, public transport provides a more convenient service to the city centre than to the airport. Public transportation utilization levels of 50 percent are not uncommon in Canada for city centre orientated trips as compared with 15 percent for airport trips. The flexibility of the mobile air terminal allows its terminus to be conveniently located relative to the main CBD transportation hubs such as bus, commuter rail, or rapid transit stations and major office buildings. In order to assess the convenience factor, four origin/destination trip factors were considered for departing residents. These factors were location of:

- place of residence
- work place
- trip origin
- return trip destination

Table 8 shows the possible trip origin/destination combinations for departing residents and ranks the likely convenience of access to the mobile terminal for each category of passenger.

Departing residents who would find the mobile terminal least convenient are those who lived and worked in the suburbs and whose trip purpose would not otherwise require them to pass through CBD of their home city.

Departing residents living in the suburbs but working in the CBD would find the mobile terminal more convenient since many of them could use the same form of transportation that they normally used in their journey to work.

Departing residents living in the suburbs starting their air trip from their place of employment in the CBD and returning directly to their suburban residence would find the service convenient for their outbound journey and possibly convenient on return depending upon their travel to work arrangements.

Passengers living in the suburbs and originating and terminating their air trip at their place of work within the CBD would find the STOLmobile service most convenient.

Most departing residents living within the CBD or on its periphery would find the service very convenient. Exceptions would be those whose place of work was in the suburbs and who wished to either start or end their air trip at their place of work.

Place of Residence	Place of Work	Trip Origin	Return Destination	Convenience Rating	Assumptions
Suburb	Suburb	Suburb	Suburb	Low	Mobile terminal less accessible than airport.
Suburb	CBD	Suburb	Suburb	Medium	Good access to CBD from suburb.
Suburb	CBD	Suburb	CBD	High	Good access to CBD.
Suburb	CBD	CBD	CBD	Very High	Good access to CBD.
CBD	CBD	CBD	CBD	Very High	Good access to CBD.
CBD	Suburb	Suburb	CBD	Medium	Inconvenient access to CBD for departure.
CBD	Suburb	CBD	Suburb	Medium*	Inconvenient access from CBD to place of work
CBD	Suburb	Suburb	Suburb	Low**	Inconvenient access to CBD.

Table 8 Mobile Terminal Convenience Rating of Trip Category

* Very few trips likely in latter three categories.
**Also inconvenient by conventional system.

The Airtransit demonstration showed that more passengers used the STOLmobile service to exit the airport than to reach it. This was primarily because more departing residents than arriving visitors had cars available. Although not specifically determined, it would appear that returning residents not having a private automobile at the airport, preferred to travel to the CBD to make their homeward travel connections by public transport.

An important consideration is whether use of the mobile terminal should be voluntary or mandatory. Maximum air carrier operating costs would result if it were necessary to operate both mobile and fixed-airport passenger facilities. However, operating and capital costs savings associated with a mandatory system could be offset by lost air fare revenue if large numbers of passengers found the mandatory service inconvenient and for this reason switched to other carriers.

The traveller least likely to use the mobile terminal would be one who could reach the airport more conveniently than the mobile terminal departure point. For the three airports under consideration for the Canadian STOL system, access times to the proposed STOLport and to the CBD's are approximately equal in each case. The main differentiating factors would be the convenience, cost and availability of parking. Based on these factors, mandatory mobile terminal useage would be more acceptable at Toronto than at Montreal or Ottawa where adequate parking could be readily provided at the STOLports.

5.3 Passenger Handling

Conventional airports have two passenger interfaces, one between the access system and the terminal building and the other between the terminal building and the aircraft.

The road to the terminal interface is common to both systems since passengers are required to provide their own transportation to the either the mobile or fixed terminal. However, because it would be located near the point of origin or destination of a significant proportion of the trips, pedestrian access is an important consideration for the mobile terminal but is not a factor at conventional terminals. The second interface, between the aircraft and the terminal, would be largely eliminated with the mobile air terminal concept since it would link directly with the aircraft. Typical passenger handling sequences for both the conventional air terminal and the mobile terminal concept are shown on Figure 3.

The diagram indicates that passenger handling procedures are less complicated using the mobile terminal option. In the normal case,

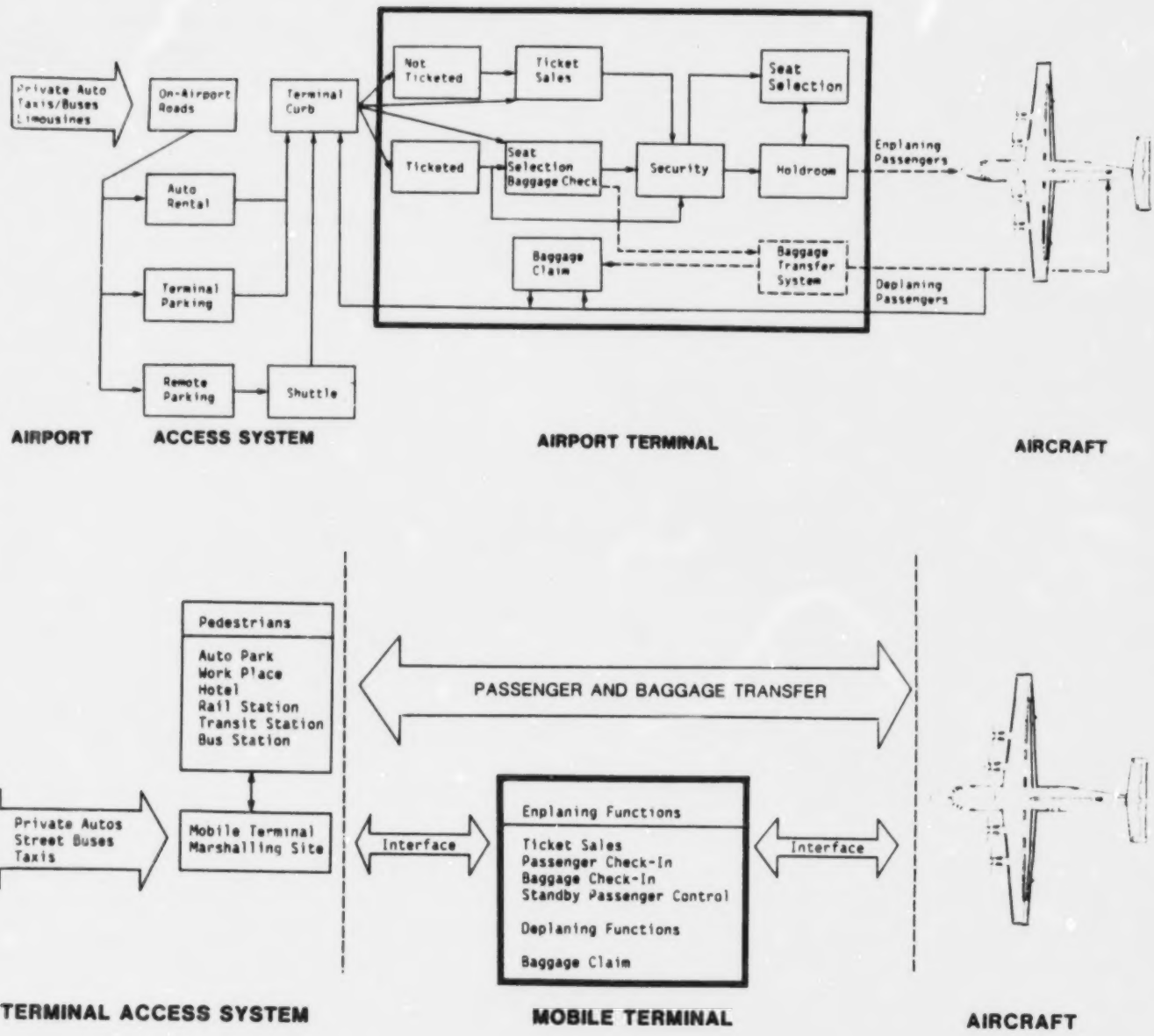


Figure 3 COMPARISON OF PASSENGER SEQUENCES

once the passenger and his baggage are checked on board, no further processing is required until the passenger reaches his CBD destination and claims his baggage.

Few commuter carriers operating small aircraft can afford passenger loading bridges. At large airports long walking distances are often involved between the terminal gate and the small aircraft parking positions. The mobile terminal provides a sheltered, automated connection to the aircraft thereby improving passenger comfort and saving time.

5.4 User Costs

A common use ground transport system would be cheaper for most CBD orientated passengers than would taxis, private automobiles or other forms of public transport. Since passengers are likely to consider all costs associated with their trip, a system which provides the lowest door to door cost is likely to be the preferred option.

The Airtransit demonstration project showed a high preference for the STOLmobile service, the cost of which was covered in the fare. Given the potential superiority of the mobile air terminal over the experimental STOLmobile service, a greater preference for all inclusive "door to door" fares can be expected.

The current practice on the Toronto/Ottawa air commuter service operating from Toronto Island Airport is to include the charge for the STOLmobile service in the air fare following the example set by the Airtransit demonstration project. If the fares charged by commuter operators using mobile air terminals remain competitive with those charged by the conventional carriers, the comparative total trip costs (CBD to CBD) for the Toronto/Montreal/Ottawa system would be as follows (Summer 1985):

Total Trip Cost - Round Trip ($)

Route	Mobile Terminal System (Combined Fare)	Conventional System (Air Fare Plus Taxi Fare)	Mobile Terminal Advantage(%)
Toronto-Montreal	257	337	24
Toronto-Ottawa	224	288	22
Ottawa-Montreal	173	239	27

Potential savings of this order would provide a strong incentive to use an integrated downtown to downtown service.

5.5 Disadvantages

In its simpliest form, the service involving a mobile air terminal would have disadvantages for some passengers. Some of these disadvantages could only be overcome by reducing the level of service to the majority of the intended users.

For example, the system would not provide convenient service for interlining or connecting air passengers. Such passengers would have to be handled by exception and the procedures would depend upon the nature of the air operations and facilities available at each airport and the number of passengers involved.

During periods of severe delay, most passengers would be required to wait within the central business district. This would be an advantage to some who could use the waiting time beneficially either for business or recreation. Passengers accompanied by small children might have difficulty in finding suitable waiting areas within the CBD and would prefer a system that allowed waiting at the airport. This deficiency could be overcome by providing waiting space near the mobile terminal CBD terminus but this may not always be practical.

The most significant level of inconvenience would be experienced by those persons wishing to provide their own transportation directly to the airport. Vehicle parking in "satellite" lots, involving an intermediate stop for the mobile terminal might be considered but this could introduce the same level of complexity as an on-airport terminal since fixed standby facilities and baggage check-in arrangements might also be required.

6. COMMUNICATIONS AND CONTROL EQUIPMENT

The mobile air terminal would require on-board communications and control systems which would allow it to operate from remote locations such as off-street parking lots or curb-side on-street parking positions. The electronic equipment would include both passenger processing and vehicle dispatch systems.

6.1 Equipment Availability

The electronic equipment necessary for the system to meet the specified operational requirements can be considered under three functional headings:

1. Passenger Servicing,
2. Vehicle Dispatch and Communications, and
3. Central Control.

A survey of available equipment showed that the necessary system components were available "off the shelf". Some of this standard equipment may require adaptation for mobile use (through special packaging and mounting) but most items under consideration are suitable for immediate installation in mobile vehicles.

Some of the proposed components are available from a number of manufacturers, so such equipment has been identified only by type. Where availability is more limited, or where the equipment has been specifically developed for mobile applications, specific manufacturers are named.

During the equipment availability review, a number of discussions were held with RMS Industrial Controls Inc. who specialize in the development of computer aided dispatch systems and Automatic Vehicle Monitoring (AVM) systems. Applicable equipment manufactured by this firm is described in this report in order to demonstrate the system. Such mention is not intended however to endorse the product as similar equipment manufactured by others may also be available. The RMS system is described on Figure 4. Another system (DATAP) which might also have application is outlined on Figure 5.

The system described in this report would be applicable to a major commuter operation. (The proposed Toronto/Montreal/Ottawa service was used as the model.) Its scope and scale could be considerably reduced for smaller systems involving fewer or smaller airports or aircraft.

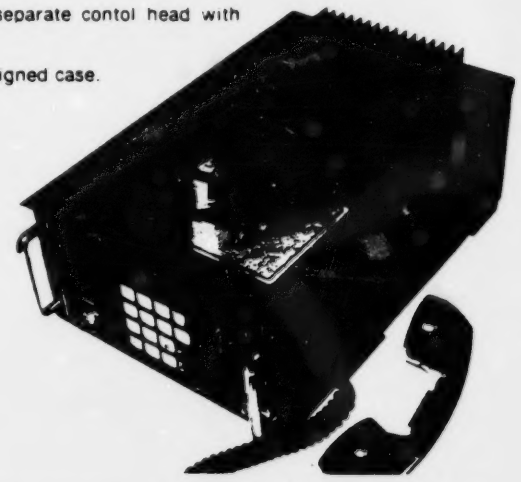
CADCOM II

AUTOMATIC VEHICLE MONITORING (AVM) COMPUTER AIDED DISPATCH (CAD)

Capital equipment costs form a significant part of today's resource and service industries. Firms whose operations incorporate medium to large size fleets of costly vehicles must examine efficient means of vehicle dispatch in order to optimize the fleet size. The RMS CADCOM II series of Computer Aided Dispatch (CAD) and Automatic Vehicle Monitoring (AVM) equipment is designed to allow fleet operators more efficient utilization of these vehicles, whether they be heavy-haul resource vehicles, light delivery service vehicles, or public transit vehicles.

FEATURES OF THE CADCOM II AVM SYSTEM MOBILE TERMINAL UNIT

- 32-character LCD alpha-numeric readout offering multi-lined scrolled information.
- Visual indicators for transmit, request-to-talk, and cleared-to-talk.
- 16-key input for driver response and information transfer.
- Mobile unit is available as a total integrated one-cabinet unit, or as a separate contol head with remote mounted communications package.
- Full duplex telephone-like voice communication capability — ruggedly designed case.
- Three levels of automatic vehicle location accuracy and complexity offered.
- Options:
  - Fully integrated automatic vehicle location receiver
  - Optional custom-designed keyboard
  - Separate control head
  - Boom microphone
  - Multiple input isolated junction plate
  - Analog input expandability
  - Alpha-numeric printer compatible
  - Integrated public address system



RADIO SPECIFICATIONS

TRANSMITTER

Design Concept	Direct Digital Synthesizer with Micro Strip Technology
Frequency Range	406 MHz to 512 MHz ‡
Channel Spacing	12.5 KHz or 25 KHz
RF Power Output	0.25 W to 40 W (separate heat sink mount supplied)
Harmonic Emission	-60dB min.
Frequency Stability Modulation	Typically ± .0002% over -30°C to +60°C † Voice-Preemphasized +1 -3dB of a 6dB per octave from 300 to 3000 Hz Data - Flat Over - 0 to ± 5 KHz
Audio Sensitivity	.08 V ± 3dB for 60% max deviation at 1 KHz
FM Noise	Typically 60dB below 60% deviation at 1 KHz
Audio Distortion	Typically less than 1% at 1 KHz -60% max. deviation
Duty Cycle	100%
Power Efficiency	35%-40%
Card Size Dimensions	8 in. x 4 in.
Output Impedance	50 ohm

RECEIVER

Design Concept	Direct Digital Synthesizer with Micro Strip Technology and Phase Lock Loop Recovery
Frequency Range	406 MHz to 512 MHz ‡
Channel Spacing	12.5 KHz or 25 KHz
Sensitivity	EIA SINAD .35 microvolts
RSS-119-9.4 Selectivity	Exceeds -70dB
Frequency Stability	Typically ± .0002% over -30°C to +60°C †
RSS-119-9.5 Spurious Response	Exceeds -70dB
RSS-119-9.6 Intermodulation Spurious Response	Exceeds -60dB
RSS-119-9.7 Spurious Emissions	Less than 2000 pico watts
Card Size Dimensions	8 in. x 4 in.
Input Impedance	50 ohms
Audio Output Option	10 watts min. into 8 ohms

‡ Series 402 - 400 to 440 MHz
Series 442 - 440 to 470 MHz
Series 472 - 470 to 512 MHz

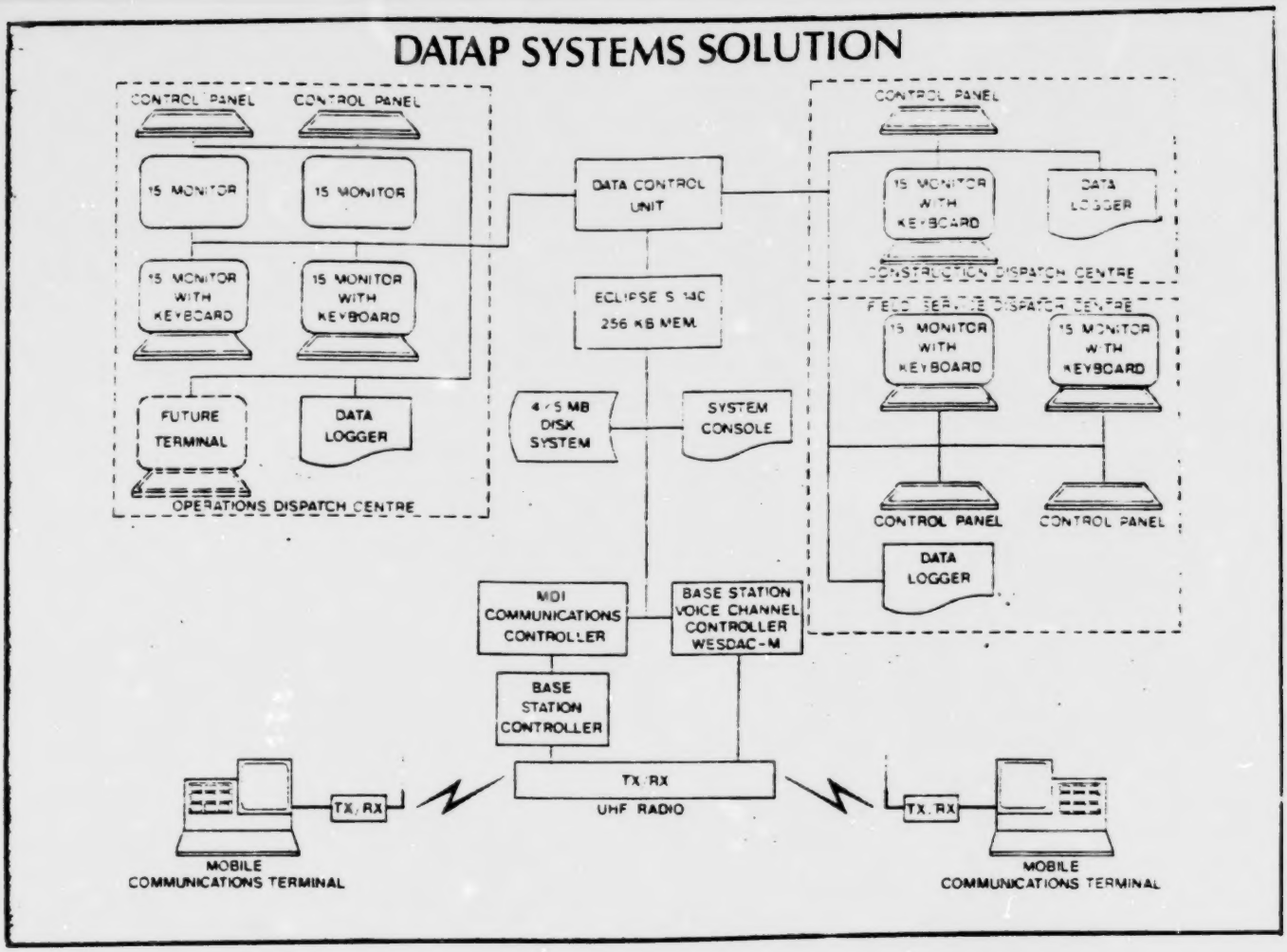
† Lower temperatures optional

OVERALL TRANSCEIVER DIMENSIONS

Width - 425 mm (16.75 in.) Depth - 324 mm (12.75 in.)
Height - 140 mm (5.5 in.)

NOTE: Width will change when optional 19 in. rack mount kit is specified.

Figure 4 MOBILE COMMUNICATIONS UNIT



The automated radio dispatch system (ARDS) was designed for digital and voice communications between three dispatch centres (Operation, Construction and Field Service) and about 100 mobile units with expandability to 256 terminals. The mobile data terminals use a full duplex 4800 baud UHF radio channel for digital communication while the voice traffic is dedicated to the alternate channel. This approach maximizes the availability of the data link by eliminating the problem of channel contention.

Responding to trouble calls, dispatchers prepare special messages (documents) required for particular jobs. A document is received by the mobile terminal, the vehicle operator performs the assigned task as described in the document is updated and transmitted back to the operator to record job completion. The computer tracks all documents in the system from their inception to job completion.

Project highlights include:

- Selective calling of vehicles by dispatcher;
- Selective calling of dispatcher by vehicle;
- Automated or manually initiated voice fall back mode of operation;
- Vehicle operator status, location and availability reporting;
- Operations override condition activation or deactivation;
- Vehicle operator message alert;
- All points bulletin;
- Dispatcher voice traffic control aids;
- System monitoring aids
- Document and Switching sheet step dispatching;
- Document hard-copy logging;
- Automated job completion control;

The modular system design concept includes provision for future addition of miniature, hard-copy printers in the service vehicles, which may be used to generate instant invoices at a customer's premises or the linemans work orders for his signature.

Figure 5 DATAP DISPATCH SYSTEM DIAGRAM

The on-board equipment selection assumed two person operation of the vehicle during the passenger boarding process. The driver would be responsible for monitoring vehicle dispatch, related communications and for loading passenger baggage. An attendant would be stationed at the passenger check-in position and would be responsible for passenger ticketing and check-in, but need not accompany the vehicle to the aircraft. During off-peak periods, or for smaller systems both the dispatch and passenger servicing functions could be handled from a single station.

At some airports some passengers may prefer to provide their own transportation, others may be interlining and some, such as the handicapped may require special assistance. It was therefore assumed that there will be more than one passenger check-in point in each airport system and that passengers must be accommodated on a first-come-first-served basis regardless of their point of entry.

6.2 Passenger Servicing

A flow diagram depicting proposed passenger processing options described in the following is shown in Figure 6.

Passenger Reservations

An air service of the size under consideration would probably require a central computerized passenger reservation system. Superimposing the mobile terminal information and processing requirements on an existing reservations system could be very difficult both in terms of software revisions and computer operating system and hardware modifications. It is therefore proposed that a separate host computer be provided for accommodating the passenger servicing, communications and dispatch functions associated with the mobile terminal. This computer could be dedicated to this use or if located at the airport, it could also be used for other lower priority applications such as apron vehicle scheduling or allocating.

The proposed procedure would require that at a predetermined time, say one hour before scheduled flight departure, all passenger data relating to the flight being boarded would be transferred in batch form from the central reservations computer to the host computer. Thereafter any changes to the passenger files could only be made by terminals linked directly to the host computer. This procedure would apply at all airports in the system. The flight status report would also be transferred from the central computer to the host computer. This file would indicate the number of reserved seats on the flight and the names of wait listed and standby passengers.

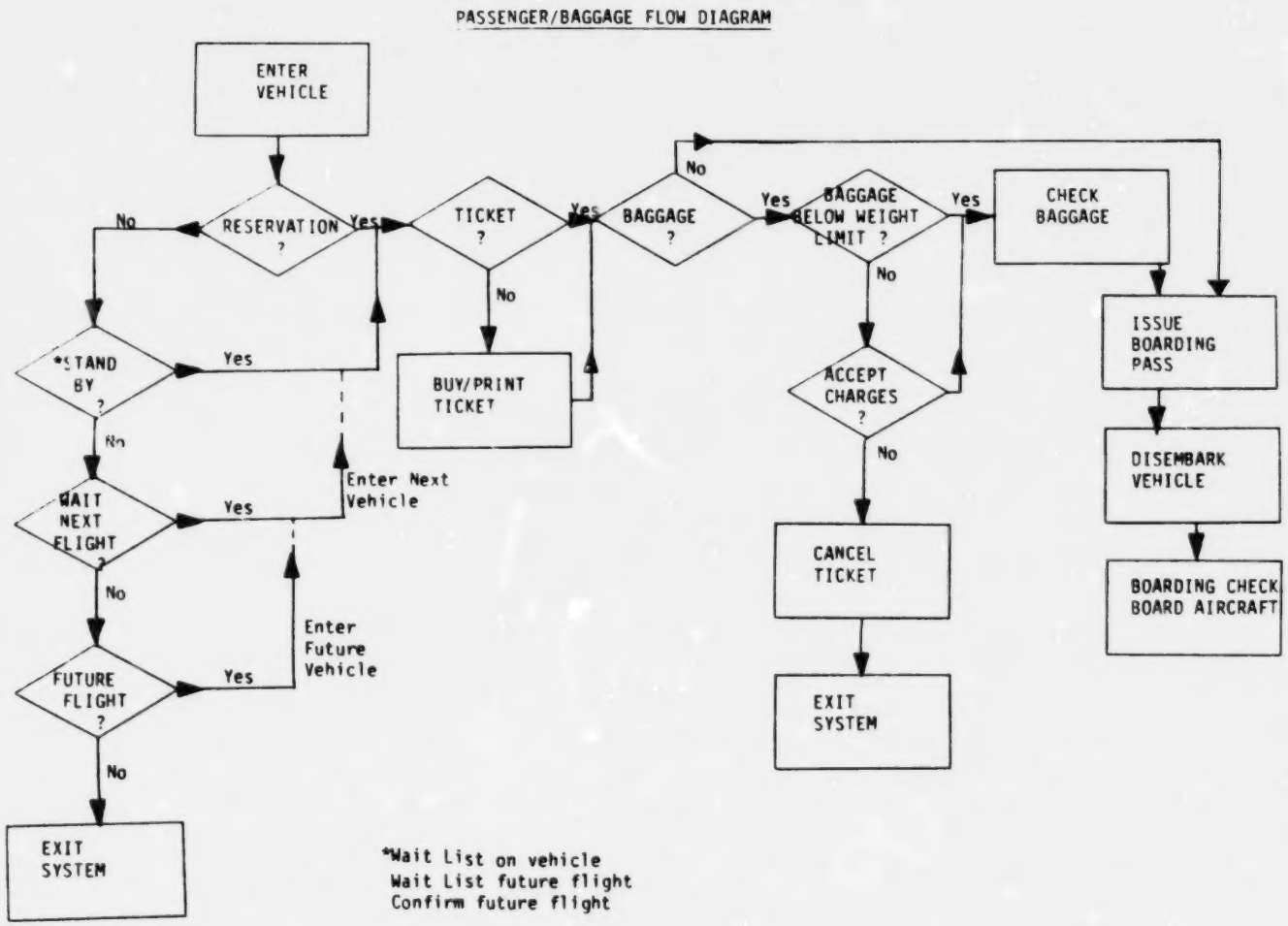


Figure 6 PASSENGER FLOW DIAGRAM

Passenger Check-In

Passengers waiting to board the mobile terminal would fall into one of four categories, those having:

1. a valid reservation and a ticket
2. a valid reservation but no ticket
3. no reservation and a ticket
4. no reservation and no ticket.

Passengers in any of the four categories may also have baggage to check in.

Check-in procedures for the the four passenger categories would be as follows:

Ticketed Passengers With Reservations

The check-in attendant would confirm the reservation by interrogating the passenger list stored in the host computer. Upon confirmation, a boarding card would be issued; the flight status report, also stored within the host computer would be updated to indicate that a seat on the aircraft had been taken.

Non-Ticketed Passengers With Reservations

Reservations would be confirmed and the flight status report amended as in the former case. Passengers with valid credit cards would have their cards read by magnetic card reader, the data required for billing purposes would be stored and a ticket printed, all automatically.

Ticketed and Non-Ticketed Passengers Without Reservations

Passengers in this category could either be wait listed or travelling standby. The two types of passengers would be handled in a similar manner except that wait listed passengers would have first call on available seats.

The flight status file in the host computer would be interrogated by the mobile terminal attendant and if seats were available, passengers would be processed in the same manner as those with reservations.

If no seats were available on the departing flight the passengers would be assigned a consecutive standby number in the order in which they entered the system. Seats to standbys would be assigned in sequence regardless of point of system entry up to the time of vehicle departure.

Passengers not successful in obtaining seats could either exit the system or retain their position in the standby list as they chose. They could either wait for the next vehicle, or if a terminal building were available at the airport, they could proceed directly to it.

The check-in position on the mobile terminal would be equipped with a computer terminal having a fully duplexed data flow radio link with the host computer. In its most flexible form, the terminal would be a mini computer complete with keyboard, monitor, credit card reader and ticket printer.

6.3 Computer Aided Dispatch

Under normal operating conditions, standard radio vehicle dispatch procedures would be followed. The vehicle would be equipped with a mobile computer-aided dispatch terminal which would be fully multiplexed and have transmitting and receiving capabilities for both voice and data. In the system proposed as the model, the equipment would have an RS232 port which would accommodate the on-vehicle passenger check-in terminal and its peripheral components.

Mobile air terminal or aircraft status reports and instructions could be relayed either in alpha-numeric format for screen display or by voice.

Information intended for passengers could be relayed either by direct voice to an on-board public address system or as standard messages by means of a voice synthesizer.

6.4 Automatic Vehicle Location

Some operators might wish to monitor the position of the vehicle at all stages of its trip cycle. Therefore, an added feature of the system could be automatic vehicle location equipment. In the RMS system this equipment could be integrated to form a combined vehicle dispatch and location monitoring unit.

The vehicle location equipment could consist of signal radio beacons transmitted out at predetermined locations along the vehicle route. As the vehicle passed a transmitter beacon, its signal would be received by the on-board radio. This signal would then be relayed to the control centre where the position of the vehicle would be determined automatically and the information displayed.

6.5 Central Control

The central control system would provide the necessary facilities for co-ordinating the following functions:

- passenger boarding;
- terminal dispatch and monitoring;
- gathering, formatting and transmitting statistics to the main system computer for processing.

The control centre could be located at the airport or elsewhere. The main advantage of on-airport location is that the vehicle control function could be combined with other similar operational activities at the airport leading to possible economies by sharing employees and equipment.

The central control function would utilize a mini-computer directly linked to the central reservations system. The computer would have the capacity to store flight lists (54 passengers plus standby and waiting lists) for as many flights are likely to be boarding simultaneously. It would also store the flight status reports for such flights.

The data gathering and processing systems would have to handle the following information:

- passenger statistics and summaries;
- flight movement data and loads;
- on time performance of vehicles and aircraft;
- equipment utilization;
- passenger billing information; and
- statutory reporting information.

This information would be assembled in the host computer and transmitted to the central computer in batch form.

The host computer would also be linked to fixed check-in and reservation terminals to accommodate non-mobile terminal users. If the computer were required to serve other airport operations, additional peripheral equipment input could be required.

6.6 Operating Frequencies

The RS232 radio modem investigated for study purposes operates on the 450 MH_z spectrum. Such frequencies are very scarce in Toronto and probably at other major urban centres. If the system were to be considered for the Toronto area, the possibility of obtaining a license to operate in the 800 MH_z spectrum should be examined.

7. VEHICLE CONSIDERATIONS

Standard or modified highway and transit buses are often used to transport passengers from downtown air terminals to on-airport terminals. Mobile apron lounges, some being standard buses and others incorporating very sophisticated mechanical systems to access the aircraft, are widely used to transport passengers between the airport terminal gate and the aircraft. This report examines the technical requirements for a vehicle which accommodates the functions of both road and apron vehicles in a single unit.

7.1 State of the Art

Some of the earliest remote terminals were located in the centres of large cities and provided flight specific bus services to the main airport. Passengers would be checked in at the downtown facility, seats would be confirmed and their baggage would be checked through to the aircraft. If the vehicle was delayed, the flight would be held up pending the arrival of confirmed passengers. Such services have now largely been discontinued partly because the very complex nature of airport operations at major centres makes the co-ordination of flight specific vehicles and baggage control difficult and partly because airport access in most centres is highly congested making the on-time performance of road vehicles problematic.

Also, the concept under consideration differs from earlier ones in that the airports to be served are near city centres, having high passenger market concentrations. The envisaged airline operations are of the simple, shuttle commuter type involving a few relatively small aircraft facilitating integration of vehicle and aircraft operations.

The road vehicles currently used in conjunction with off-airport terminals are conventional transit or highway buses, sometimes modified to facilitate self-handling of baggage. These vehicles generally operate on fixed schedules with the passenger being responsible for determining the time to be allowed for reaching the airport. Arrival times and flight connections are consequently not usually guaranteed.

A large variety of special vehicles have been developed for transferring passengers between airport passenger terminals and parked aircraft. The simpliest of these are large buses with low floors and large doors designed to facilitate the pick-up and drop-off of passengers at apron level. Passengers are required to use air stairs to reach and leave the aircraft. Weather protection is not usually provided so that the principal advantages of this system are reduced walking distances, improved passenger safety and increased airport efficiency resulting from the utilization of aircraft parking positions beyond normal walking distances.

Such vehicles generally do not meet highway licensing criteria and so can only operate within designated areas on the airport.

Special purpose vehicles or lounges have also been developed to link directly with the aircraft door, thereby eliminating the need for air stairs. These lounges fall into two categories, those which accomplish the necessary level change by lowering or raising the entire passenger cabin (Figure 7) and those which have built-in adjustable ramps (Figure 8). The majority of these vehicles are special-purpose since standard road vehicle chassis usually cannot accommodate the large bodies necessary to handle passenger loads carried by wide-bodied jet aircraft. One notable exception is the Icarus of Hungary design (Figure 8) which is an adaption of the standard articulated transit bus manufactured by that firm.

Existing passenger transfer lounges are considered unsuitable as mobile air terminals for the small commuter operations envisaged in this study for the following reasons:

- Most available models are too large.
- The mechanism for coupling with the aircraft is generally too complex.
- Most lack a baggage check-in and handling capability.
- Most could not be licensed to operate on public roads.
- They are too expensive for small commuter operators.
- They lack the necessary electronic systems for passenger processing.

7.2 Basic Vehicle Selection

The vehicle should accommodate up to 50 passengers, mostly seated, and their baggage. Two standard types of vehicles of adequate size and designed to operate on the public road system, are transit and highway buses. Transit buses are readily available in a variety of body forms and drive trains. As a rule they have low floors to facilitate fast and convenient entry and exit of passengers at street curb level. This is an advantage for urban operations where short stopping times are important and where easy access is required to accommodate the physically handicapped, passengers travelling with small children and the elderly. The low floor requires that wheel wells be provided at four locations in the vehicle and these constrain seating arrangements (bench seats are usually placed over the wells, sometimes at greater than standard heights). This is not a serious factor in transit operations where average passenger trips are short and people are prepared to stand, particularly when the vehicles travel at low speeds so that acceleration and deceleration forces are moderate. The vehicles usually do not have baggage storage space, though not a serious problem on commuter services since the vehicle is not intended to provide a door to door service thereby discouraging passengers from carrying heavy articles.

Increase Airport Terminal capacity

THE TRANSDEVCO LIFT-LINER

This new passenger handling vehicle is designed to:
- ---Operate and interface at higher speeds.
- ---Interface with all commercial aircraft.
- ---Travel over major highways and access roads.
- ---Maneuver in rough or soft terrain.

Large doors and clear, unobstructed bridge and aisles permit smooth traffic flow to minimize aircraft turn-around times.

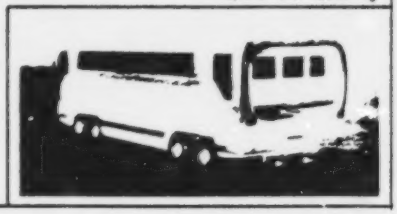
All driver controls on the bridge assure optimum ease, speed and safety of operation and handling. "Wide-body" interior with large windows, foam seats, and carpeted floor assures passenger comfort.

Capacity:		
	Seated Passengers	= 90
	Standees	= 60
	Total	= 150

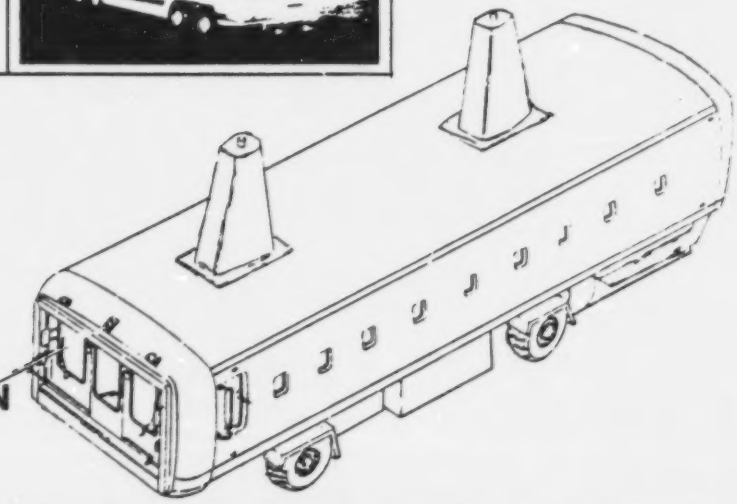
SPECIFICATIONS

Engine: Detroit 8V71 with Allison HT740 Transmission

Overall Length with Bridge retracted	48'-0"	=14630mm
Overall Width Less Mirrors	14'-0"	= 4270mm
Overall Height Lowered	14'-0"	= 4270mm
Floor Height Lowered	6'-0"	= 1830mm
Floor Height Max. Raised Position	18'-0"	= 5500mm
Axles - 2 Fixed Driven, 2 Steerable		
Max. Operating Speed	38 mph	= 60 km/h
G V W	76,000 lbs.	=45500 kg



Boothe Airside SYSTEMS INC.®
555 East City Line Avenue • Bala Cynwyd Pa 19004
PLANE MATE VEHICLE J0586 100000



SCREW LIFT CABIN

Figure 7 MOBILE LOUNGE-ELEVATING CABIN

Figure 8 MOBILE TERMINAL-ADJUSTABLE RAMP

Highway buses, can be similar in size to transit buses, but are designed to serve passengers travelling long distances often accompanied by heavy baggage and parcels. Higher speeds combined with longer travel distances generally require that seating be available for all passengers and that a more comfortable environment be provided than that usually available on transit buses. In order to maximize seating and to provide adequate storage for baggage, most road buses have their floor located above the wheels. The seats are laid out uniformly on a flat deck and the space below the floor is compartmentalized to accommodate baggage and parcels. Toilet facilities are also often provided.

A disadvantage of the high floor is the requirement for on-board stairs which are often more difficult to negotiate than those on transit buses. This is not a serious consideration since baggage and parcel check in facilities combined with under floor storage is provided eliminating the need to carry bulky articles into the vehicle. Also loading and unloading times are less critical than on transit buses because of the longer stage lengths involved with highway buses.

While either type of vehicle could be converted into a mobile terminal, the highway bus is preferred for the following reasons:

1. Its higher floor reduces the difference in elevation between it and the aircraft floor.

2. The absence of wheel wells increases seating capacity and flexibility.

3. Underfloor storage of baggage simplifies baggage handling.

4. Superior performance over long travel distances where higher speeds are an advantage.

Lower capacity operations than those assumed in this study could favour transit-type buses since both baggage handling and passenger seating could be provided at the same level for small passenger loads.

The physical relationship between the two types of buses and commuter aircraft (in this case the de Havilland Dash 7) is shown on Figure 9. The floor height of the Prevost Mirage XL highway bus is 53 cm compared with the sill height of 47 cm for the Dash 7. A similar situation pertains with many of typical aircraft types examined (Table 4). In most cases, the bus to aircraft floor level differential can be accommodated by a simple articulated ramp.

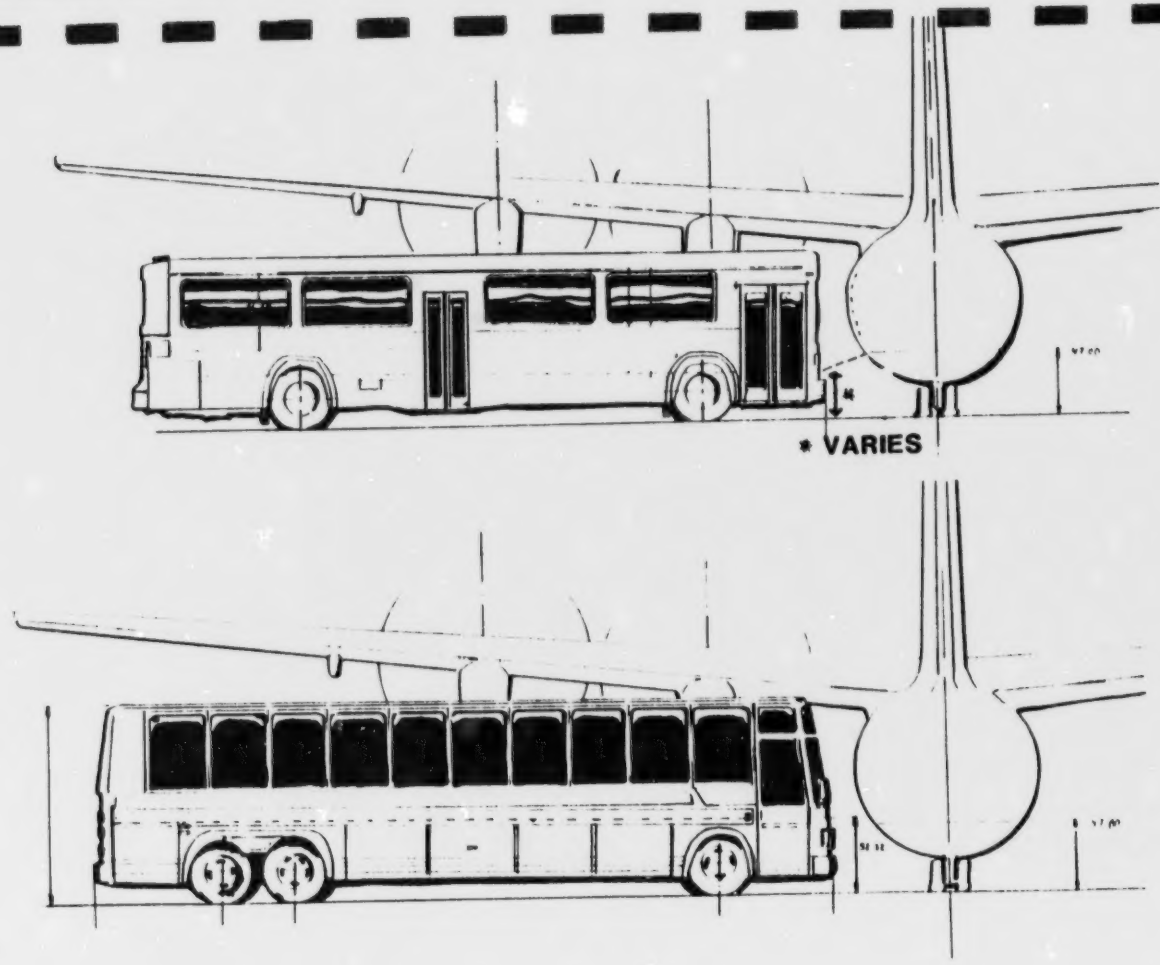


Figure 9 AIRCRAFT/BUS INTERRELATIONSHIP

7.3 Aircraft Loading System

A weather-proof mechanical linkage between the road vehicle and the aircraft is recommended. In order to minimize development costs, this link should be physically compatible with the standard bus. More sophisticated connections could be examined at a later date once the concept had proved itself. All of the aircraft considered have side loading doors. Buses could either be parked head on at right angles to the aircraft and load passengers through the front or they could be parked parallel to the aircraft fuselage and load passengers through the side.

Loading from the rear of the bus was rejected because major modifications would be required to the engine compartment of most rear-engined buses. Furthermore, the risks involved in backing a large vehicle up to an aircraft could require the use of sophisticated guidance equipment before the procedure would be acceptable to some air carriers. While both problems can be solved, other loading arrangements appear to be preferable.

Front Loading

All of the aircraft types considered had main cabin doors positioned to permit access by bus sized vehicles for front loading. Two methods of achieving a passenger connection between the vehicle and the aircraft were examined. For both solutions, the bus would be fitted with an extendable covered ramp which could be moved forward and retracted either hydraulically or manually and would fit within the bus envelope beside the driver. In one concept (shown on Figure 10) the mechanism would be extended to mate with the aircraft and a flexible rectangular membrane would envelope the aircraft door opening to form a weather-tight seal. The aircraft door would then be lowered into a pocket and a lightweight ramp would be lowered and extended forward to form the pedestrian walkway. These operations would be considerably less complex than those involved with standard fixed aircraft loading bridges.

The main operational disadvantage of the concept is that the aircraft and vehicle would be physically linked by the partially lowered aircraft door. An inadvertent movement of either the vehicle or the aircraft could result in significant damage which could leave the aircraft unairworthy. However, all aircraft and vehicle interfacing involve some risk and the proposed linkage can be made to operate as safely as any.

A second solution which is not shown would be to allow the aircraft door to be lowered in the normal manner prior to extending the closure mechanism. Once the closure was complete a simple ramp would be dropped into place to provide the pedestrian linkage. A disadvantage of this solution is that a two metre separation would

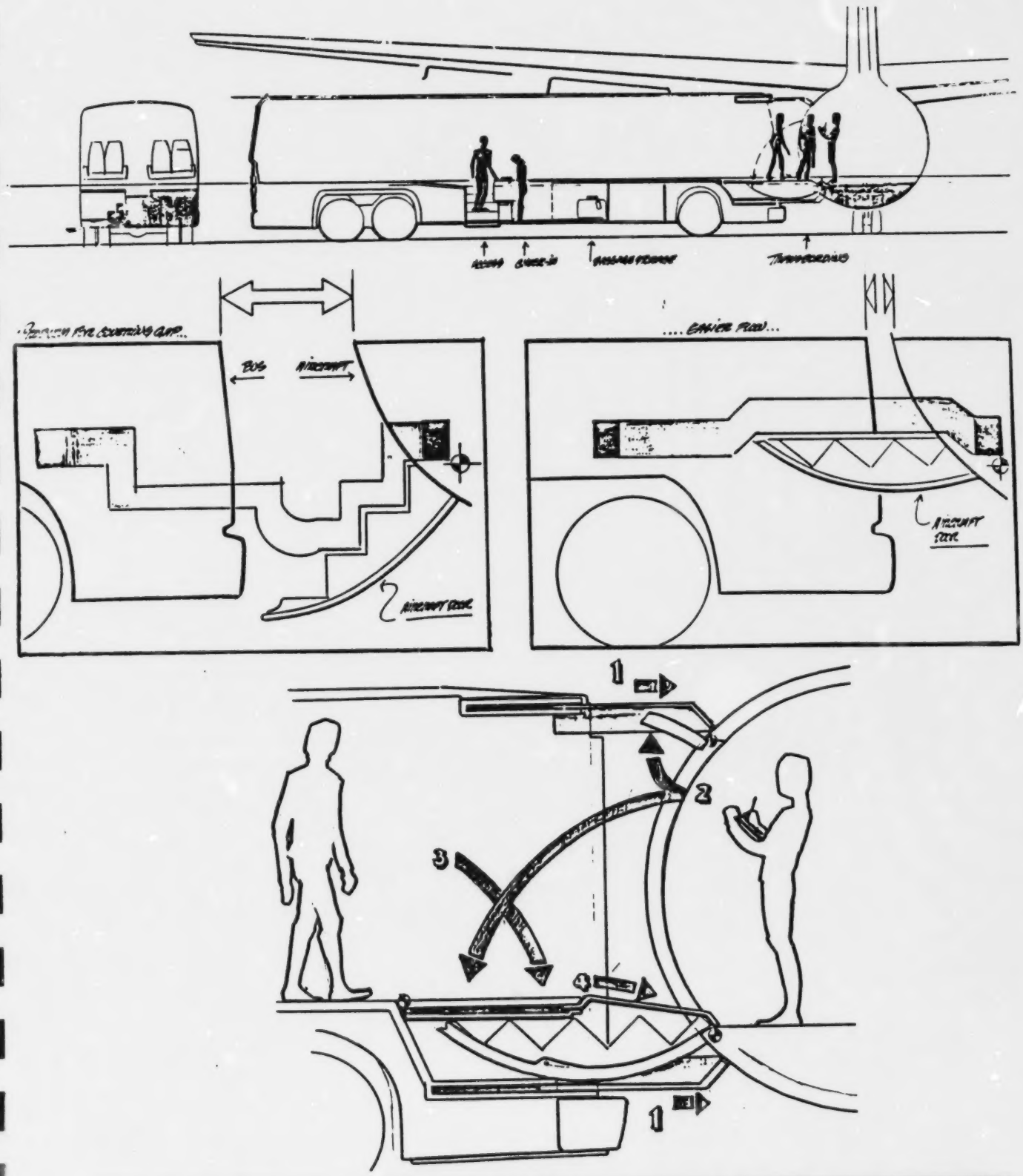


Figure 10 FRONT LOADING MECHANISM

have to be maintained between the front of the bus and the side of the aircraft. (Figure 11) A telescoping closure mechanism capable of two metres of travel would be quite bulky and difficult to accommodate at the front of the bus without interfering with the driver's vision.

Both alternatives have serious disadvantages as prototype solutions because they require cutting through the front panel of the bus. Most buses have their climatic control and similiar equipment located in this area and the costs involved in redesigning and relocating these systems are believed to be excessive in the context of prototype development.

Side Loading

The side loading option requires parking the bus parallel to the aircraft with the passenger linkage mechanism aligned with the aircraft passenger door. The passenger connection would move at right angles to the centre line of the bus and could be either of the two types described for the front loading option.

The mechanism in its extended and its retracted positions is shown on Figure 12.

The preferred location for the side loading connection is at the front of the bus. Unfortunately, most highway buses have little space available ahead of the front wheel and this lack of space restricts the width of connection that is possible. Placing the connection behind the front wheel overcomes the space problem but with some aircraft there would be insufficient clearance from the wing to allow the vehicle to align itself with the cabin door. With the Dash 7 aircraft, it would be possible to accommodate a connection either in front of or behind the front wheel.

Modifying the front of the bus to accommodate a wider unit would not be practical in prototype development, but it should be practical for production units, since only a short extension to the bus would be required.

7.4 Passenger Entry and Baggage Handling

Passenger and baggage entry to the vehicle are closely related problems since the preferred arrangement would be for the passenger and his baggage to be checked in simultaneously. Figures 13, 14 and 15 show a number of solutions to the baggage handling problem for the side and front aircraft loading options. In the simpliest case, the passengers would enter the vehicle through a side door, drop their bags on the curb for attendant loading, or place their baggage into a

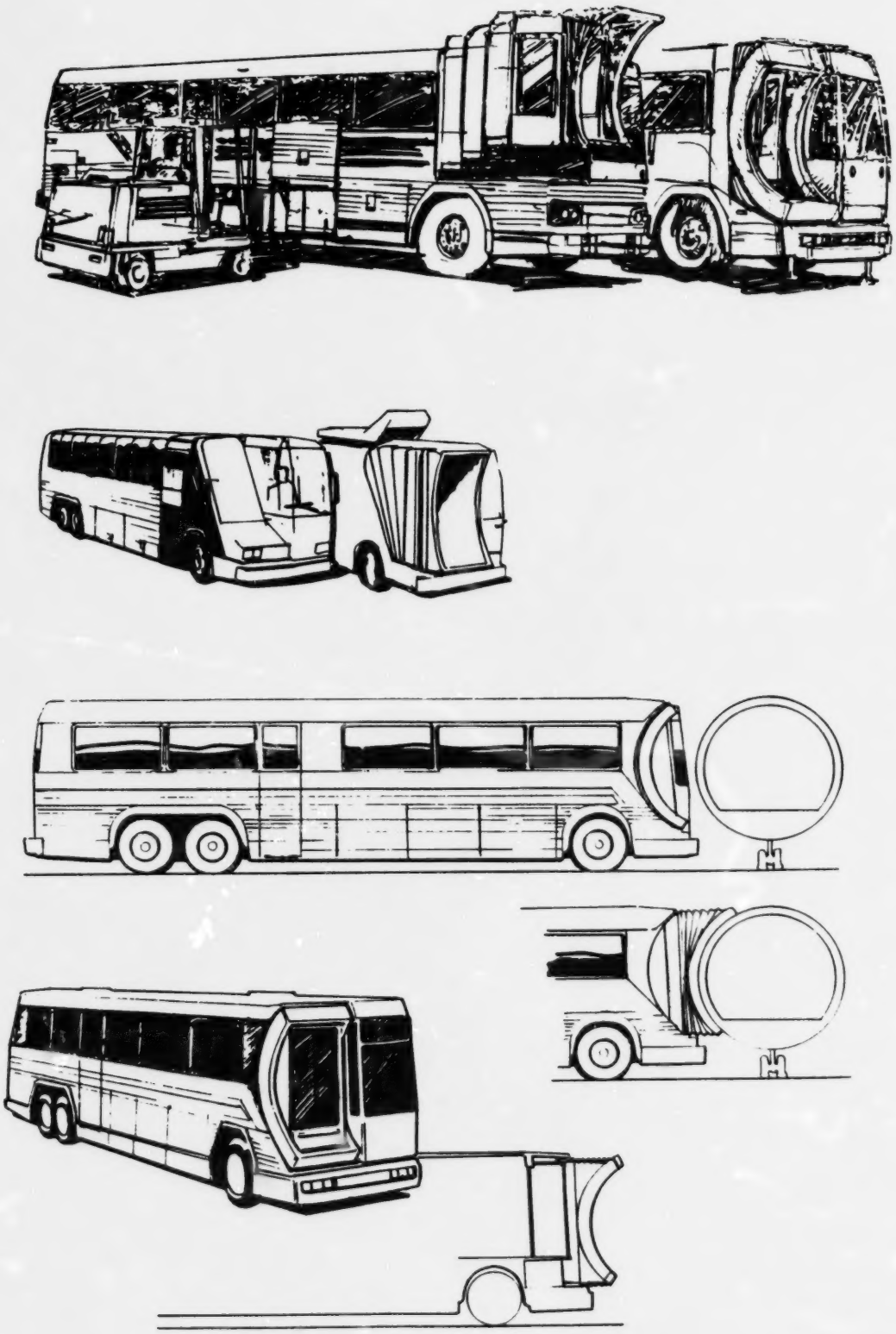


Figure 11 FRONT END EQUIPMENT OPTIONS

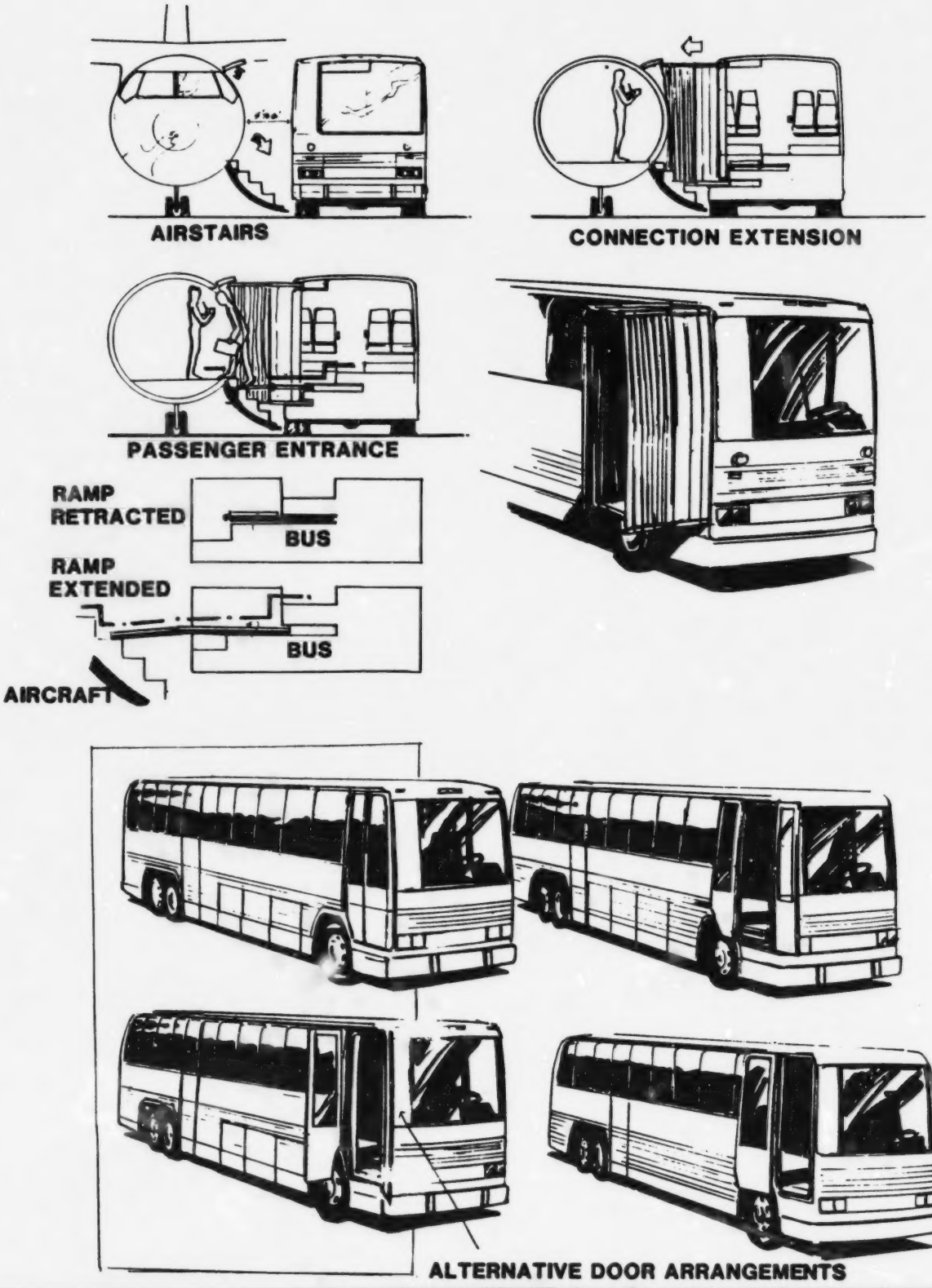


Figure12 SIDE LOADING OPTION

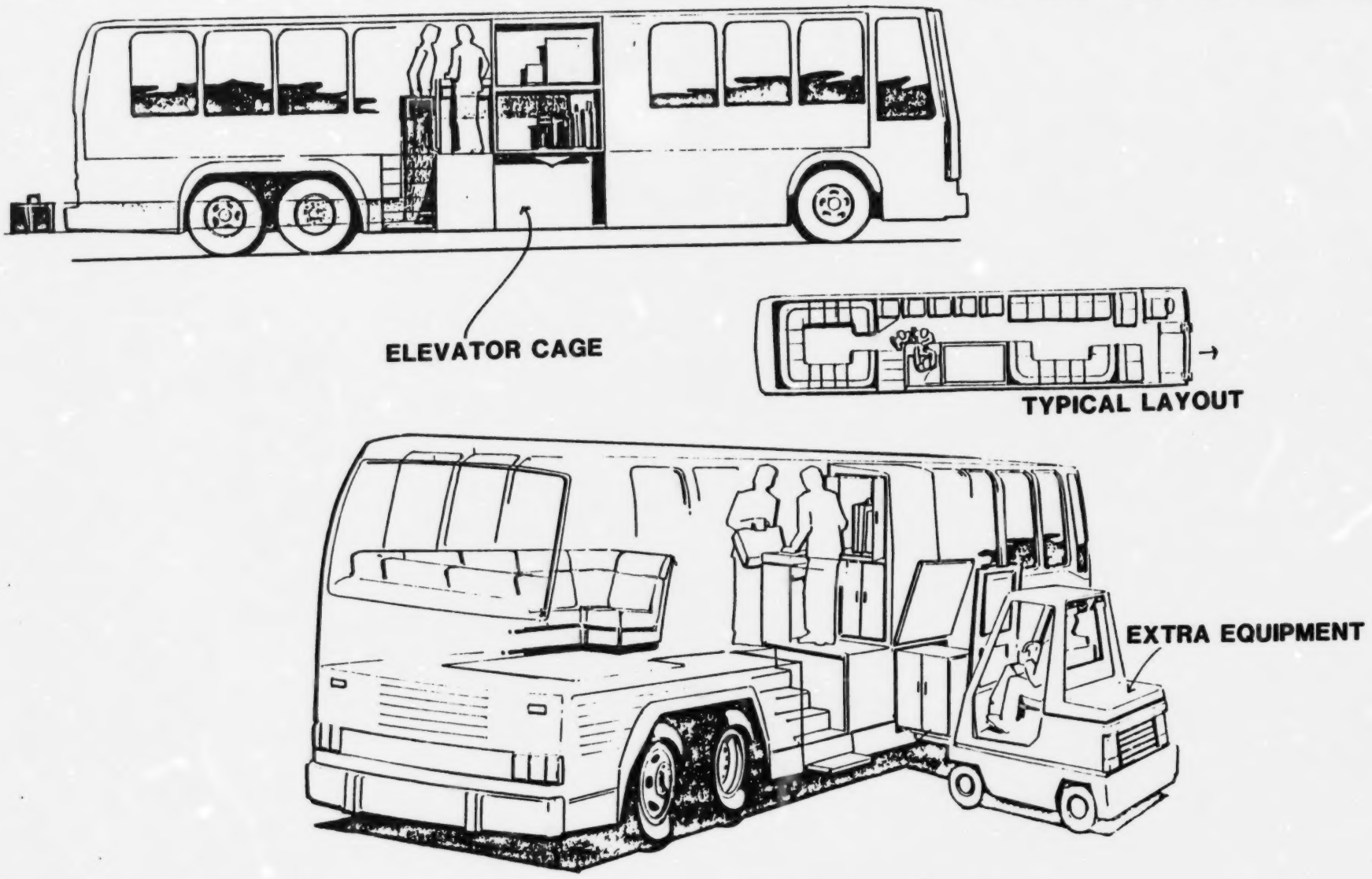
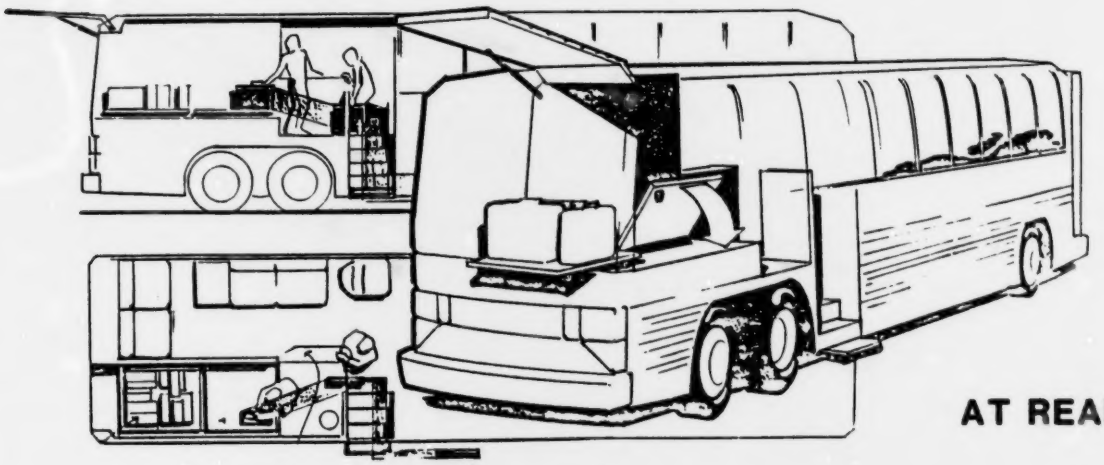
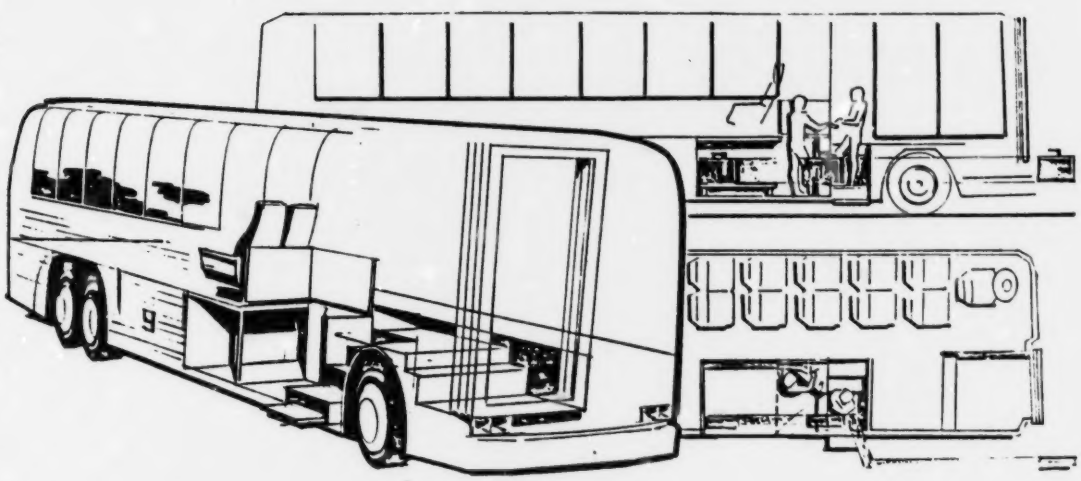


Figure 13 BAGGAGE HANDLING- CONTAINER/ELEVATOR CONCEPT

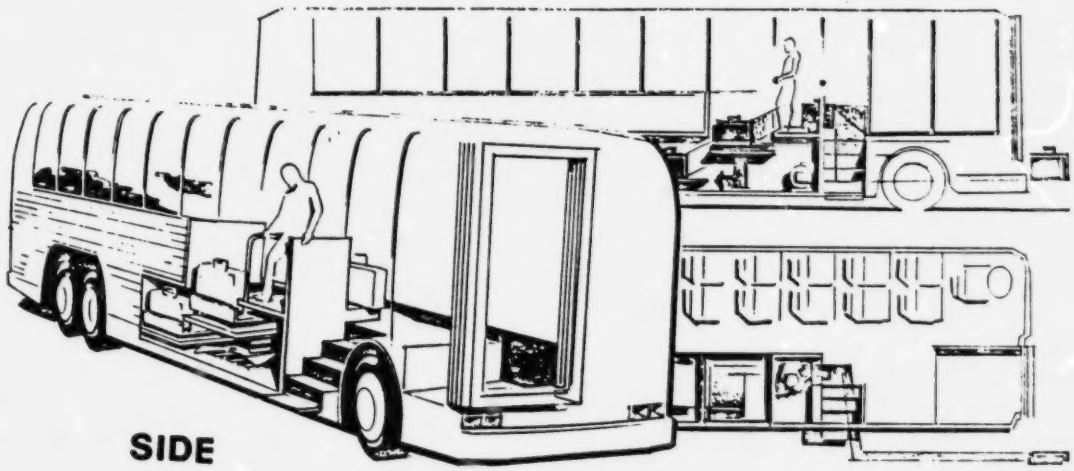


AT REAR



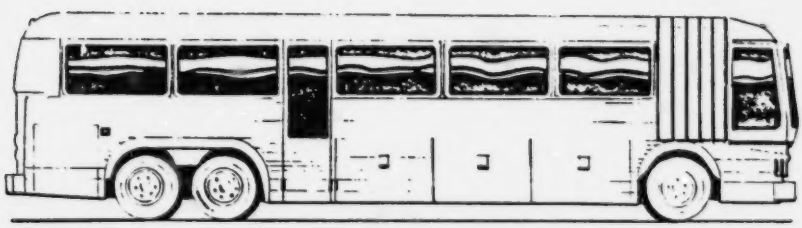
HORIZONTAL FLOW

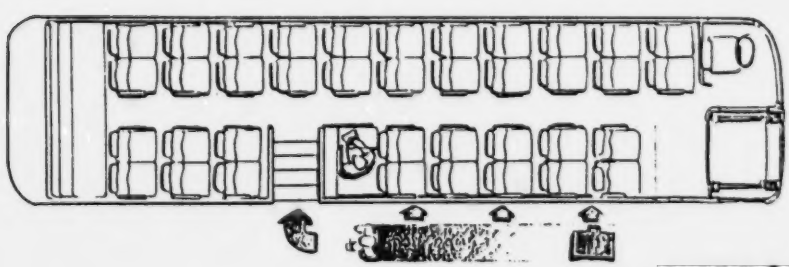
Figure 14 BAGGAGE HANDLING OPTIONS - 1



SIDE

ELEVATOR





CURBSIDE

Figure 15 BAGGAGE HANDLING OPTIONS - 2

standard underfloor baggage compartment. A disadvantage of this solution is that the driver would have to control the baggage loading to ensure that allowable weights were not exceeded. A problem would arise with standby passengers whose bags could not be loaded until they were confirmed for the flight. Also communications between driver and the control centre would be impaired.

The next most simple arrangement and possibly the preferred one, would be to check in both passengers and baggage at a position located on the bus near curb level. Checked baggage would be placed directly into a modified baggage compartment immediately behind the attendant. Standby passengers could carry their bags into the vehicle but would deliver them for storage once their seats were confirmed.

Other more sophisicated solutions which might be examined include vertical baggage elevators transferring baggage between the interior of the cabin and the storage compartments and containerized baggage systems to facilitate both vehicle and aircraft loading. The disadvantage of containerized loading is that the shape of the baggage compartments in many small aircraft, including the Dash 7, are irregular making containers impractical.

Figure 16 shows the proposed baggage handling arrangement for the side aircraft loading option. Some of the concepts shown for the front loading option are also possible with side loading.

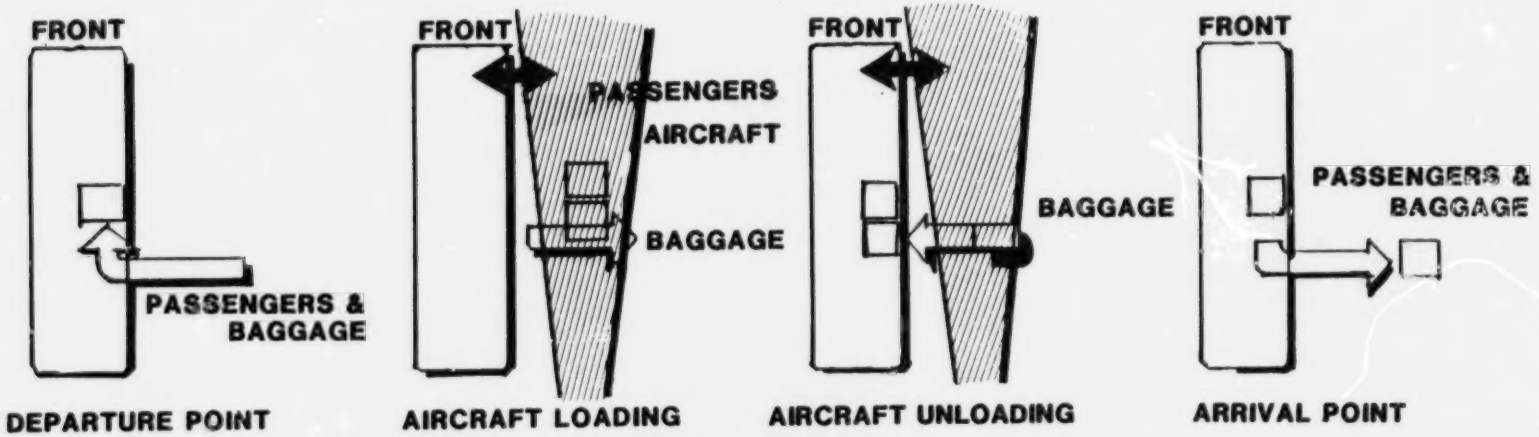


Figure 16 BAGGAGE HANDLING - SIDE LOADING CONCEPT

8. CONCLUSIONS

The proposed designs are conceptual and the assessment of their practicability has been largely judgmental. Sources in both the bus and aviation industries were consulted regarding the general practicability of the proposed solutions and the relative difficulty in achieving them. In general terms, side loading is considered to be more feasible than front loading but the precise solution requires further analysis and detailed design. There is also the possibility that more simple physical and operating solutions than those proposed could adequately demonstrate the practicability of the concept.

8.1 Market Demand

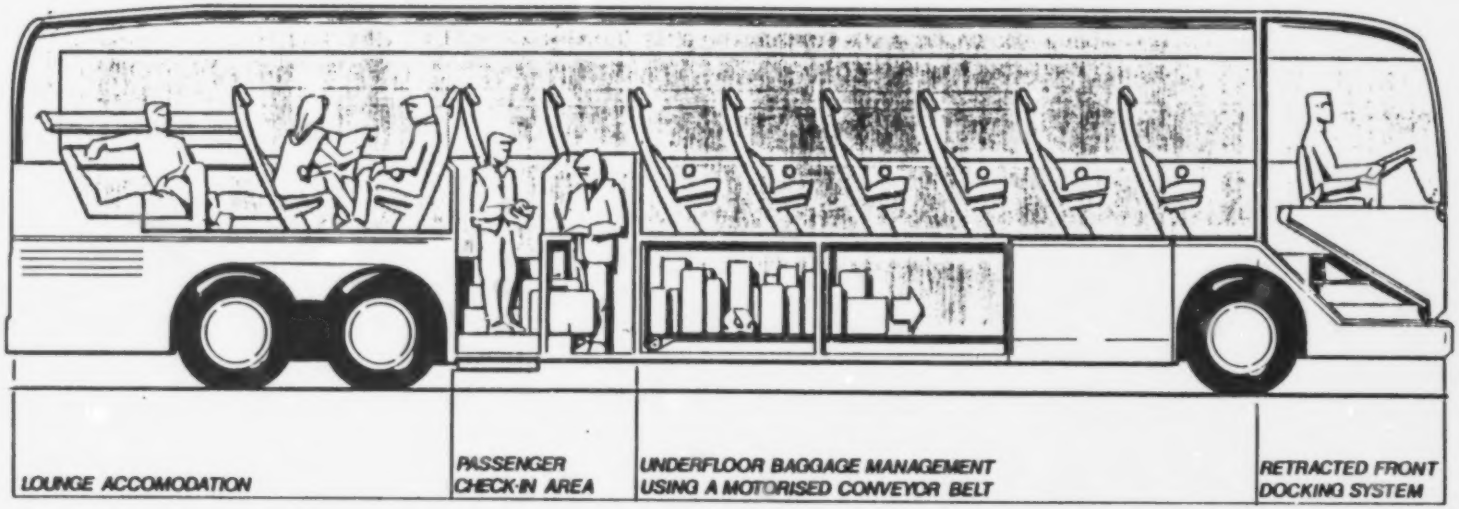
The market study indicated that there were a number of situations in the United States and Canada which might benefit from improved passenger access systems between city centres and the airport. This view is confirmed by discussions with the possible operators of the Toronto/Montreal/Ottawa STOL system and is further supported by the fact that an existing commuter operator, using Dash 7 aircraft between Toronto Island and Ottawa, is already operating a simplified form of the system described in this report. However, the potential market is a highly specialized one which will be difficult to reach, particularly for Canadian manufacturers, since it lies mostly in the United States. A favourable aspect is that the investments in toolage and fixtures would not be large since the modifications envisaged are well within the capability of most competent bus body shops and no sophisticated components need be manufactured for prototype purposes.

8.2 Communications and Control Systems

The communications and control systems in both the operations centre and the mobile vehicle can be assembled from off the shelf components. Variations of the required system are already in service in urban transit and taxi operations and for controlling maintenance vehicle fleets. A major supplier of similar systems has reviewed the specifications and has expressed the opinion that the satisfactory system can be readily assembled. The operating procedures would have been developed and agreed with the air carrier who would operate the prototype and appropriate software would have to be written and developed.

8.3 Vehicle Considerations

The preferred vehicle for the prototype would be a highway bus because it has a higher floor facilitating convenient aircraft connections and has an underfloor baggage compartment which could be adapted for passenger baggage check-in. The side loading option appears to be most practical for prototype purposes since it would require the least modifications of existing standard vehicles. A second side door would have to be provided for loading and unloading passengers at the curb.


LOUNGE ACCOMODATION
PASSENGER CHECK-IN AREA
UNDERFLOOR BAGGAGE MANAGEMENT USING A MOTORISED CONVEYOR BELT
RETRACTED FRONT DOCKING SYSTEM

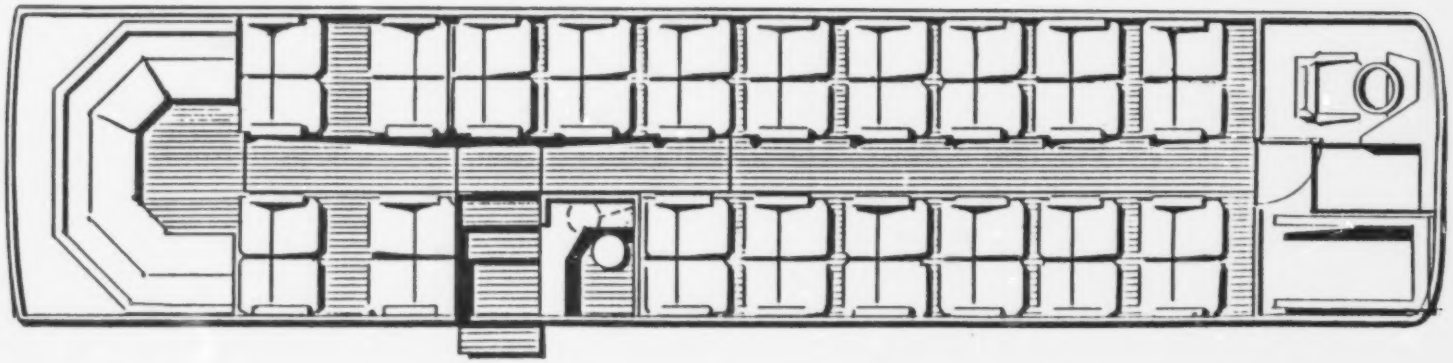


Figure 17 TYPICAL LAYOUT

The mechanical linkage between the aircraft and the bus as presently conceived is simple and could be readily fabricated and assembled within a bus body shop. Simpler solutions might also exist and these should be examined during the prototype development stage.

A typical layout with a front linkage to the aircraft and side curb level entry for baggage and passengers is shown on Figure 17. The capacity of the vehicle can be increased by reducing the number of seats and increasing the area available for standees.

8.4 Estimated Costs

The design concept was not detailed to the point where reliable cost estimates could be made. However, order of magnitude estimates for the operations and control systems indicated a cost of approximately $10,000. per unit. The cost of the electronic equipment and software associated with the control centre is dependent upon the volume and complexity of the carrier operations. For demonstration purposes, a simple control centre could be established for approximately $15,000. and a further $20,000. to $30,000. might be involved developing computer test software.

The cost of modifying a standard bus is the most difficult to estimate because of the lack of detailed drawings either for the connecting mechanism for the modifications to the bus. However, indications are that a prototype unit adequate for demonstration purposes could be developed for approximately $70,000. The capital cost of an appropriate highway bus having the necessary capacity would be approximately $200,000. This would include installation of the bus to aircraft linkage mechanism, provision of a new side entry door and installation of a combined passenger and baggage check-in station. The costs of system design, testing and demonstration would be additional.

Number/
Numéro

2

Transport Canada
Development

Transports Canada
Développement

TP 5985E

Mobile Air Terminal Research

Summary Report

Prepared for
Transportation
Development Centre

Transport Canada

MARCH 1985

CA1
DTC 849
85
M51S
c.2

Canada

TP 5985E

MOBILE AIR TERMINAL RESEARCH

Summary Report

by

IBI GROUP

Associated Consultant

GSM DESIGN INC.

Library and Information Centre
Centre de Documentation (GSL)
RECEIVED – REÇU LE
SEP 13 1985
Publication Officielle
Transports Canada / Transports Canada

Authors

George Sladek

Carol Soukup

March 1985

The contents of this report reflect the opinions of the Consultants and are not to be construed as the official policy of the Transportation Development Centre.

Dimensions and measurements contained in this report may appear in both imperial and metric quantities as a reflection of common usage and standard practice of the aviation and bus industries.

REPORT DOCUMENTATION FORM

1. Transport Canada Report No	2. TDC Project No.	3. Recipient's Catalogue No.
TP 5985E	6183	

4. Title and Subtitle	5. Report Date
MOBILE AIR TERMINAL RESEARCH SUMMARY REPORT	March 1985
	6. Performing Organization Report No

7. Author(s)	8. Transport Canada File No
SLADEK, George, SOUKUP, Carol	D1455-101-20

9. Performing Organization Name and Address	10. DSS File No
IBI Group 156 Front Street West, 6th Floor Toronto, Ontario M5J 2L6	14SD.T8200-3-3606
	11. DSS or Transport Canada Contract No OSD84-00009

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Transportation Development Centre (TDC) Complexe Guy Favreau 200 Dorchester Blvd. West Suite 601, West Tower Montreal, Quebec H2Z 1X4	April 1984- March 1985
	14. Sponsoring Agency Code TDC 6183

15. Supplementary Notes	16. TDC Project Officer
Summary of "Mobile Air Terminal Research" TP#6429E March 1985	Trevor Smith

17. Abstract

This report presents findings and recommendations for a mobile air terminal to supplement or replace conventional air terminals, particularly at small domestic commuter airports. The concept envisages the modification of a standard highway bus to a vehicle capable of operating on highways and airport aprons. It would contain all facilities required to check in passengers at a downtown street curb, transport them and provide a weatherproof direct connection to the aircraft. Deplaning would occur in a similar reverse fashion. This concept would provide passengers with a level of convenience exceeding any current operating system.

The study established the physical and operating system requirements and demonstrated the concept's technical feasibility including the electronic data and communications systems for computerized pasenger and baggage check-in, ticket sales, aircraft load control and vehicle dispatch, which would be assembled with off-the-shelf components. Conversions of the highway bus for side or frontal loading/unloading (of passengers) were successfully demonstrated. A number of solutions appear practical for on-vehicle baggage check-in and storage.

The concept was designed to service the de Havilland Dash 7 aircraft, but is believed adaptable to most commuter-type aircraft in the 20- to 50-seat range.

18. Key Words	19. Distribution Statement
STOLport, Mobile Air Terminal, Bus, Passenger Transfer Vehicle, Baggage, Computer Reservations, Commuter, Dash 7, Economic, Operations	Limited number of copies available from the Transportation Development Centre

20. Security Classification (of this report)	21. Security Classification (of this page)	22. No. of Pages	23. Price
Unclassified	Unclassified	23	Nil

TDC CDT 79-005

FORMULE DE DOCUMENTATION POUR RAPPORT

1. N° du rapport Transports Canada	2. N° de l'étude — CDT	3. N° de catalogue du destinataire
TP 5985E	6183	

4. Titre et sous-titre	5. Date du rapport
MOBILE AIR TERMINAL RESEARCH SUMMARY REPORT	mars 1985
	6. N° du rapport de l'organisme exécutant
7. Auteur(s)	8. N° de dossier Transports Canada
SLADEK, George, SOUKUP, Carol	D1455-101-20
9. Nom et adresse de l'organisme exécutant IBI Group 156 Front Street West, 6th Floor Toronto, Ontario M5J 2L6	10. N° de dossier — ASC 14SD.T8200-3-3606
	11. N° de contrat — ASC ou Transports Canada OSD84-00009
12. Nom et adresse de l'organisme parrain Centre de développement des transports (CDT) Complexe Guy Favreau 200 ouest, boul. Dorchester Suite 601, tour ouest Montréal, Québec H2Z 1X4	13. Genre de rapport et période visée avril 1984 - mars 1985
	14. Code de l'organisme parrain CDT 6183
15. Remarques additionnelles Recapitulation de "Mobile Air Terminal Research" TP # 6429E mars 1985	16. Agent de projet — CDT Trevor Smith

17. Résumé

Ce rapport présente les résultats d'une étude sur les terminus aéroporteurs sur roues pour remplacer ou compléter les aérogares classiques et plus particulièrement les petits aéroports régionaux. Le concept envisagé est de transformer un autocar classique en un véhicule apte à évoluer sur l'aire du trafic d'une aérogare tout en maintenant ses qualités routières et qui comporterait les équipements nécessaires à l'enregistrement des passagers ainsi qu'une passerelle escamotable protégeant ces derniers des intempéries à l'embarquement. L'autocar modifié, ferait la navette entre l'aéroport et le centre-ville, et offrirait une commodité aux passagers, supérieure à tous les systèmes actuels en service.

L'étude définie les caractéristiques physiques et opérationnelles du terminus envisagé et démontre la faisabilité technique du concept et des systèmes informatiques et de communications nécesaires à l'émission automatique des billets, l'enregistrement des passagers et des baggages, le contrôle de la charge de l'avion et à la répartition, le tout à partir d'appareillage présentement disponible sur le marché. La possibilité de transformer indifféremment l'autocar ordinaire en terminus mobile à passerelle d'embarquement latéral ou frontal. Diverses solutions semblent pratiques pour la prise en charge et la manutention des bagages.

Quoique l'étude soit axée sur la desserte des DASH 7 de de Havilland, elle pourrait être adaptée à la desserte de la plupart des avions de transport régional de 20 à 50 places.

18. Mots-clés	19. Diffusion
ADACport, terminus aéroportuaire sur roues, autobus, transbordeur, bagages, réservations automatisées, transport régional, Dash-7, economie.	Le CDT dispose d'un nombre limité d'exemplaires.

20. Classification de sécurité (de ce rapport)	21. Classification de sécurité (de cette page)	22. Nombre de pages	23. Prix
non classifié	non classifiée	23	---

ACKNOWLEDGEMENT OF PARTICIPATION

This study (Mobile Air Terminal Research) was conducted on behalf of the Government of Canada, Transportation Development Centre.

Industry support has been generously provided by Prevost Car Inc., Canavia Transit Inc. and The de Havilland Aircraft of Canada.

TABLE OF CONTENTS

		PAGE
1.0	INTRODUCTION	1
1.1	Background	1
1.2	Study Objectives	1
1.3	Project Methodology	3
1.4	State of the Art	3
2.0	MARKET SURVEY	4
2.1	Methodology	5
2.2	Demand	5
3.0	OPERATIONAL REQUIREMENTS	
3.1	Passenger Check-In	6
3.2	Operations Centre	6
3.3	Passenger Vehicle	7
3.4	Baggage Handling	7
4.0	PASSENGER TERMINAL	8
4.1	System Variables	8
5.0	POTENTIAL BENEFITS TO USERS	10
5.1	User Characteristics	10
5.2	Convenience of System Access	10
5.3	Passenger Handling	11
5.4	User Cost Savings	12
6.0	COMMUNICATIONS AND CONTROL EQUIPMENT	12
6.1	Equipment Availability	13
6.2	Passenger Servicing	13
6.3	Computer Aided Dispatch	14
6.4	Automatic Vehicle Location	14
6.5	Communication and Control	15
7.0	VEHICLE CONSIDERATIONS	16
7.1	Vehicle Selection	16
7.2	Aircraft Loading System	18
7.3	Passenger Entry and Baggage Handling	20
7.4	Feasibility and Costs	20

LIST OF TABLES

	PAGE
TABLE 1 - AIR TERMINAL BUILDING AREA COMPARISON	9

LIST OF FIGURES

	PAGE
FIGURE 1 - MOBILE AIR TERMINAL CONCEPT	2
FIGURE 2 - AIRCRAFT/BUS INTER-RELATIONSHIP	17
FIGURE 3 - FRONT END EQUIPMENT OPTIONS	19
FIGURE 4 - SIDE LOADING OPTION	21
FIGURE 5 - BAGGAGE HANDLING - SIDE LOADING CONCEPT	22

1.0 INTRODUCTION

The Mobile Air Terminal Research report documents investigations into the feasibility of converting a standard highway bus into a computer equipped mobile air terminal for checking in passengers and baggage and transferring them directly from a downtown city curb to a waiting aircraft for departure. Similarly, deplaning passengers and baggage would be transported directly from the aircraft to a central downtown curb. Such a system could improve passenger convenience and reduce passenger facility costs at airports. The concept is illustrated in outline form on Figure 1.

1.1 Background

The mobile terminal concept is an extension of on experimental STOLmobile service, the practicability of which was confirmed during the 1974 Transport Canada Air Transit demonstration project. In order to prove the viability of the STOLmobile concept for commercial operators, a prospective STOL air commuter operator in the Toronto/Montreal/Ottawa corridors conducted two demonstrations, (one in October 1983 and the second in January 1984), during which passengers were loaded on to a highway bus in downtown Toronto, transported to, and loaded directly on to de Havilland Dash 7 aircraft at Toronto Island Airport. These experiments showed that the entire boarding operation could be completed within an elapsed time of approximately 20 minutes measured from the time of closing of the bus door following passenger pick-up to the closing of the loaded aircraft door (loads of approximately 35 passengers).

The conclusions of the test were that the concept has the potential to provide a high level of service to passengers and that it can reduce requirements for passenger and related facilities at airports, thereby reducing overall airport capital and operating costs.

Discussions with officials of the Transportation Development Centre, raised the possibility that a mobile terminal may have applications beyond STOL particularly at commuter airports where the air service was provided by a single carrier operating small aircraft. These discussions formed the basis for the research summarized in this document.

1.2 Study Objectives

The principal objective of the research project was to prepare a conceptual design for a ground vehicle incorporating a standard road bus chassis which would allow passengers to be processed on board, and would be capable of transporting them directly between off-airport locations and the aircraft.

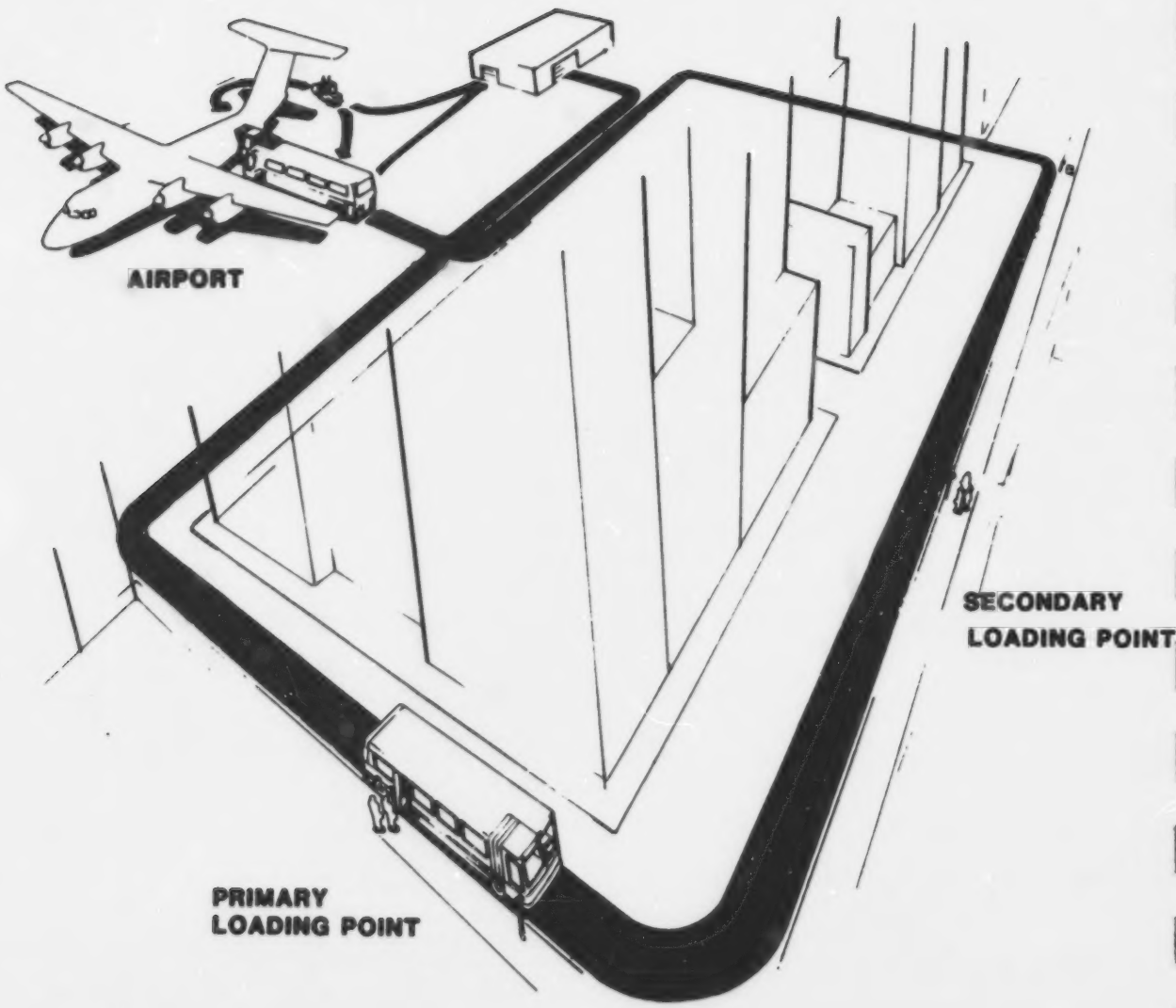


Figure 1 MOBILE AIR TERMINAL CONCEPT

A secondary objective was to carry out a survey of the potential air commuter market to determine the number, size and location of carriers who might find the concept advantageous; to obtain information cn the size and distribution of the various types of aircraft in common service; to ascertain the complexity of the problem of providing a direct physical connection between the vehicle and the aircraft to facilitate passenger transfer.

1.3 Project Methodology

The following methodology was employed to achieve the objectives of the research:

a. A market survey was carried out to determine the number of air carriers in Canada and United States operating aircraft in 19 to 60 seat range.

b. A review of manufacturers' literature was carried out to determine the state of the art regarding apron passenger transfer vehicles.

c. Interviews were conducted with manufacturers of conventional buses to determine the practicability of converting their standard equipment into mobile air terminals. The availability of suitable off-the-shelf electronic communications and data processing equipment was also determined.

1.4 State of the Art

The proposed concept falls generally into the category of flight specific off-airport (remote) passenger processing systems. Some of the earliest remote terminals were located in the centres of large cities from which flight specific bus services were provided to local airports. Passengers would be checked in at the downtown facility, seats on the aircraft were confirmed and baggage was checked through to the aircraft. If the vehicle was delayed, the flight would be held up pending the arrival of confirmed passengers at the airport.

Such services have now largely been discontinued because the complex nature of airport operations at major centres make the co-ordination of flight specific vehicles, baggage control and aircraft scheduling difficult. Also, traffic congestion on airport access routes in most centres leads to poor on time performance of road vehicles. The previous practice of delaying aircraft for the benefit of a few passengers is no longer considered acceptable given current highly interactive air route structures.

The concept under consideration differs from the historic case in that some of the airports intended to be served by it are near city centroids and the intended passenger market. Also the proposed complimentary airline operations are of the simple, domestic shuttle commuter type, involving relatively small aircraft.

The road vehicles currently used in conjunction with off-airport terminals are conventional transit or highway buses, sometimes modified to facilitate self-handling of baggage by passengers. These services generally operate on fixed schedules with the passenger being responsible for determining the time that should be allowed for reaching the airport. Flight connections are usually not guaranteed.

Many special purpose vehicles have been developed for transferring passengers between the airport passenger terminal and parked aircraft. The simpliest of these are oversized buses with low floors and large doors designed to facilitate the pick-up and drop-off of passengers at the aircraft parking apron level. Passengers using these systems are required to use air stairs to reach and leave the aircraft cabin and weather protection is not usually provided. Such vehicles generally do not meet highway licensing criteria and are restricted to operating within a designated area of the airport.

Special purpose vehicles or lounges have also been developed to directly interface with the passenger terminal and with the aircraft, thereby eliminating the need for air stairs. These lounges are of two types, those which accomplish the necessary level change between the terminal floor and the aircraft floor by lowering or elevating the entire passenger cabin and those which have built-in, adjustable ramps or stairs.

Existing passenger transfer lounges are considered unsuitable as mobile air terminals for the small commuter operations envisaged in this study for the following reasons:

- most available models are too large.
- the coupling mechanisms with the aircraft are too complex.
- most lack a baggage check-in and handling capability.
- most could not be licensed to operate on public roads.
- they are too expensive for small commuter operators.
- they lack the necessary electronic system capability.

2.0 MARKET SURVEY

The objectives of the marketing study were to determine the upper limit of potential demand for mobile air terminals in Canada and in the United States and to determine the range of desirable capacities and features which might be relevant to domestic commuter air industry.

2.1 Methodology

The upper market potential for the vehicle was determined by:

a. Identifying the various types of commuter aircraft in service in Canada and the United States, within the 19-60 seat capacity range.

b. Commuter air carriers in Canada and USA were identified in terms of location, areas served, and fleet composition.

c. Assessment of relevant climatic factors affecting operations, and whether the service might be attractive to non-business travellers.

2.2 Market Demand

The market study indicated that there were a number of situations in the United States and Canada which might benefit from improved passenger access systems between urban centres and airports. This view is confirmed by discussions with the possible operators of the Toronto/Montreal/Ottawa STOL system and is further supported by the fact that an existing commuter carrier, operating Dash 7 aircraft between Toronto Island and Ottawa, is operating a simplified form of the system. However, the market is a highly specialized one and will be difficult to develop, particularly for Canadian manufacturers since most of the potential demand lies in the United States. The most promising market in terms of volume sales appears to be the development of a 10 to 15 seat bus. However, actual sales would be very much lower then that indicated since provision of the special buses would represent large capital and operating cost outlays in the context of the small scale air carrier operations generally involved.

Less potential demand measured in terms of total dollar sales exists for buses in the larger capacity range. However, the larger carriers (operators of aircraft in the 30 to 50 seat range) are more likely to be able to afford the vehicles and therefore development attention should initially be focussed on this market.

There appears to be some scope for the use of mobile terminals in specialized applications such as for transporting charter groups, aged or handicapped persons, or passengers associated with a single location such as a resort. Mobile units could also be used as decentralized "sterile lounges", for domestic security processing or for customs and immigration inspections at transborder locations, where the installation of permanent, fixed inspection and control facilities is not practical.

The most promising market for the short term is that associated with the proposed Toronto/Montreal/Ottawa STOL service. Eleven to thirteen buses in the 35 to 50 passenger capacity range could be required by late 1985 or early 1986. Although this does not represent the largest total market in terms of volume sales, it would facilitate initial market penetration and would provide the basis for developing and testing the vehicle and its operating systems.

3.0 OPERATIONAL REQUIREMENTS

Operating and physical specifications for the mobile terminal were developed on the assumption that it should be designed for applications capable of benefiting from the full capability of the concept.

The four major functions which must be accommodated are:

1. Direct passenger check-in at a curb location
2. Passenger transfer between the pick-up point and the aircraft
3. Sheltered passenger transfer to and from the aircraft.
4. Enplaning and deplaning baggage handling.

3.1 Passenger Check-In

The vehicle would be required to accommodate the following check-in functions:

- Confirmation of reservation
- Boarding pass issue
- Stand-by passenger control
- Ticket purchase and issue
- Baggage check
- Transmission of ticket sales, information and other passenger related data.

3.2 Operations Centre

The service should be capable of being controlled from a single location at each airport. This control centre could be equipped with its own computer which would be linked to the main operations and reservations computer of the airline. The operations centre would have be equipped with a voice and data communications facility to interface with the complementary mobile terminal located equipment. The centre would contain a vehicle dispatch unit which would also provide direct or indirect communications with the aircraft, the airport and with passenger aircraft parking apron operations.

3.3 Passenger Vehicle

The mobile terminal would incorporate either a city bus or a highway bus chassis currently manufactured in Canada, and would be capable of being licensed for travel on the public road system. The modified vehicle should have the following features:

1. A passenger check-in area with space for an attendant, a check-in computer terminal and ticket printer and baggage storage space;

2. Passenger seating for a minimum of 30 passengers;

3. A radio transmitter and receiver capable of both data and voice transmission for passenger processing and for vehicle dispatch control;

4. A mechanism for direct passenger transfer to the aircraft; and

5. A baggage handling and storage capability.

The connecting mechanism between the vehicle and the aircraft could be either manually or a hydraulically operated; it should provide substantially full protection against precipitation but need not be airtight. With the connection in its retracted position, the visibility of the driver should not be impaired. The vehicle must be capable of meeting all highway safety standards and should be capable of interfacing with the aircraft cabin door without modification of the aircraft's structure or door.

3.4 Baggage Handling

The mobile terminal shall be capable of accommodating baggage checked by both enplaning and deplaning passengers. A standard load of 30 passengers, would produce approximately 12 pieces of baggage on average. At an upper limit, the vehicle should be capable of accommodating at least 20 pieces of baggage. The preferred method of baggage handling to and from the aircraft, would be from a baggage compartment accessible from the outside of the mobile terminal so as not to interfere with passenger loading or unloading.

4.0 PASSENGER TERMINAL

The two most significant benefits foreseen for the mobile air terminal are a possible reduction in fixed passenger terminal facilities and an improvement in passenger level of service and convenience.

4.1 System Variables

A major effect of the mobile terminal on airport facilities would be to reduce the requirements or possibly eliminate the need for passenger terminal buildings at airports.

In order to quantify this effect, three operating options were studied including a conventional airport system, a STOLmobile system similar to that developed during the Air Transit Demonstration project but with check-in facilities available at a downtown terminal, and the mobile air terminal system.

Passenger related components of the system should accommodate the following activities:

- Passenger check-in
- Baggage check-in
- Passenger waiting and pre-boarding
- Standby passengers
- Deplaning passengers baggage pick-up
- Well-wisher waiting
- Greeter waiting
- Delayed passenger waiting
- Commercial concessions

The space required for each of these activities is a function of the peak person accumulation and the floor area to be provided for each occupant. The most severe loading will occur when flights are delayed during peak periods and the passengers associated with the delayed flights are superimposed upon to normal peak hour loads. Under these circumstances, crowding can be tolerated for short periods.

Space requirements for the three comparative systems were developed for three delay related operating conditions:

1. normal operating
2. moderate delay
3. severe delay

A. Conventional Terminal

Under normal operations all passengers would proceed directly to the terminal building. For analytical purposes, it was assumed that the terminal would have to accommodate two aircraft departures and one arrival during the peak half hour (aircraft would have 54 available seats of which 80 percent would on average be occupied during peak periods).

Under moderate airside delay conditions two aircraft loads would have to be accommodated simultaneously in the departure lounge. Under severe delay conditions three aircraft loads would be accommodated in the terminal simultaneously.

Comparative building area requirements under the three delay conditions would be as follows:

	Departure Lounge (sq. m)	Total Building (sq. m)
Normal Operating	113	177
Moderate Delay	131	195
Severe Delay	180	244

B. STOLmobile and Mobile Air Terminals

The maximum building requirements at the airport would occur with low levels of mobile lounge usage combined with severe operating delays. The airport terminal building requirements for the three delay conditions are shown on Table 1:

Percentage Vehicle Utilization	Terminal Building Area (m^2)					
	STOLmobile			Mobile Air Terminal		
	Normal Oper.	Moderate Delay	Severe Delay	Normal Oper.	Moderate Delay	Severe Delay
0*	177	195	244	177	195	244
20	154	173	216	145	159	208
40**	131	146	190	104	115	172
60**	110	109	153	74	81	126
80	79	82	128	45	48	92
100***	43	43	85	0	0	43

Table 1 Air Terminal Building Area Comparison

*Zero Vehicle Utilization Corresponds to Conventional Terminal Operations.
**Vehicle utilization assuming voluntary use.
***Mandatory vehicle use.

The space requirements of the airport terminal will depend upon whether use of the STOLmobile or mobile air terminal is to be voluntary or mandatory. Under voluntary useage, approximately 40 to 60 percent of all passengers might use it (Interpretation of Air Transit experience).

5.0 POTENTIAL BENEFITS TO USERS

It would be unrealistic to assume that any groundside passenger transfer system can provide an equally high level of service to all air passengers wishing to access a major urban airport. Therefore, in assessing the viability of the mobile air terminal concept, the two questions that were answered were:

1. Can this system provide a better level of service to the passengers for whom it is intended than already exists or is likely to be available?

2. Do potential users of the system benefit sufficiently to justify the additional cost involved in its operation?

5.1 User Characteristics

The mobile air terminal concept is being proposed as the landside component of an intra-city shuttle commuter air service involving small aircraft (less than 60 seats) operating from small inner-city airports. The principal user of such a commuter service would be a businessperson travelling from the central business district (CBD) of one city to the CBD of another city or starting or terminating a leg of his trip in the CBD of one or the other of the cities on his route.

5.2 Convenience of System Access

In most major cities, there is a high concentration of business, commercial and professional employment within the city core. A number of cities also have high quality residential areas either within their city core or immediate periphery, and residents in these areas could also benefit.

Most persons employed in CBD's have a good choice transportation modes for work trips, either in the form of private automobiles with convenient parking, rapid rail or bus transit or commuter rail. In most urban communities, public transport to the city centre is more convenient than that to the airport. Public transportation utilization levels of 50 percent or greater are not uncommon for city

centre orientated work trips; utilizations of public transport can be as low as 15 percent to many important North American airports.

The convenience of the proposed service for departing residents would vary depending upon their place of residence and their place of work as follows:

a. Departing residents who would find the mobile terminal least convenient are those living and working in the suburbs and who would not be otherwise required to pass through the CBD of their home city to reach the airport.

b. Departing residents living in the suburbs but working in the CBD might find the mobile terminal convenient since many of them would be able to use the same form of transportation that they normally used for their journey to work.

c. Departing residents living in the suburbs but starting their trip from their places of employment in the CBD and returning directly to their suburban residences on the return trip would find the service convenient for their outbound journey and possibly for the return leg.

d. Departing passengers living in the suburbs and originating and terminating their trip at their place of work within the CBD would find the service most convenient.

e. Most departing residents living either within or near the CBD would usually find the service very convenient.

The traveller least likely to use the mobile terminal would be one who could reach the airport more easily than at a mobile terminal pickup point. In the three airports under consideration for the Canadian STOL system, accessability of the airports or the pick-up points in the respective CBD's by private automobile or taxi are approximately equal. The main differentiating factors would be the relative convenience, cost and availability of automobile parking and public transport to the two locations.

Arriving passengers having their first stop with the CBD would find the service very convenient. Some others may find it less so depending upon the location of their destination relative to the airport and the CBD.

5.3 Passenger Handling

Conventional airports involve two passenger interfaces, one between the roads system and the terminal building and the other between the terminal building and the aircraft.

Passenger handling procedures would be simplier on the mobile terminal than in a fixed terminal. Under normal operating conditions, once the passenger and his baggage are on board, no

further processing would be required until the passenger reaches his destination and claims his baggage.

Few commuter carriers operating small aircraft can afford passenger loading bridges and often considerable walking distances are involved between the terminal gate and the aircraft parking position. The mobile terminal provides a sheltered connection to the aircraft thereby improving passenger comfort and saving time.

5.4 User Cost Savings

Since passengers generally consider the total cost associated with their trip, the system which provides the lowest overall cost in terms of fares and time is likely to be the preferred one.

The current practice for the Toronto/Ottawa commuter services based at Toronto Island is to include the cost of the STOLmobile service in the air fare following the example set by the Air Transit demonstration project. Assuming that air fares charged by commuter operators using mobile air terminals remain competitive with those charged by the conventional carriers, the comparative total trip costs (CBD to CBD) for the Toronto/Montreal/Ottawa system would be as follows:

Total Trip Cost - Round Trip (Dollars)

Route	Mobile Terminal System (Air Fare Only)	Conventional System System (Air Fare Plus Taxi Fare)	Mobile Terminal Advantage (%)
Toronto-Montreal	257.	337.	24
Toronto-Ottawa	224.	288.	22
Ottawa-Montreal	173.	239.	27

Potential savings of the order indicated in the table would provide a strong inducement to use the system operating an integrated downtown to downtown service.

6.0 COMMUNICATIONS AND CONTROL EQUIPMENT

The mobile air terminal would require an on-board communications and passenger control system which would allow it to operate from remote locations such as on off-street parking lots, curb-side on-street parking positions or other remote passenger pick up and drop off points.

6.1 Equipment Availability

The electronic equipment necessary for the system to meet specified operational requirements can be grouped under three functional headings:

1. Passenger Servicing
2. Vehicle Dispatch and Communications
3. Central Control

The on-board equipment selection assumed two person operation of the vehicle during the passenger boarding process. The driver would be responsible for monitoring vehicle dispatch-related communications and for loading passenger baggage. An attendant would be stationed at the passenger check-in position and would be responsible for passenger ticketing and check-in, but need not accompany the vehicle to the aircraft. During off-peak periods, or with smaller systems both the dispatch and passenger servicing functions could be handled from a single station.

A survey of equipment availability showed that all the electronic components necessary for assembling the system are available off the shelf. Some of this standard equipment may require adaptation for mobile use through special packaging and mounting but most components which would be required are already suitable.

6.2 Passenger Servicing

The following passenger servicing related functions should be accommodated within the mobile terminal:

Passenger Reservations

Superimposing the mobile terminal information and processing requirements onto an existing reservations system could be very complex both in terms of software revisions and computer system modifications. It is therefore proposed that a separate host computer be provided for accommodating the passenger servicing, communications and dispatch functions associated with the mobile terminal.

The proposed procedure would require that a predetermined time, say one hour before scheduled flight departure, all passenger data relating to the flight being boarded be transferred as a batch from the central reservations computer to the host computer. Thereafter any changes to the passenger files would be made by terminals linked directly by land line or by radio to the host computer. This procedure would apply at all airports in the system. In cases where all seats were taken, a file including the names of wait listed passengers and standbys would be established.

Passenger Check-In

Passengers waiting to board the mobile terminal would fall into one of three categories; each to be processed as follows:

Ticketed Passengers With Reservations

The check-in attendant would confirm the reservation by interrogating the flight list stored in the host computer. Upon confirmation, a boarding card would be issued. The flight status report, also stored within the host computer would then be updated to indicate that a seat on the aircraft had been taken.

Non-Ticketed Passengers With Reservations

Reservations would be confirmed and the flight status report amended as in the former case. Passengers with valid credit cards would have their cards read by magnetic card reader, the data required for billing purposes would be stored and a ticket printed automatically.

Ticketed and Non-Ticketed Passengers Without Reservations

Passengers in this category could either be on wait or standby lists. They would be handled similarly except that wait listed passengers would have priority.

6.3 Computer Aided Dispatch

Under normal operating conditions, standard radio vehicle dispatch procedures would be followed. The vehicle would be equipped with a mobile computer-aided dispatch terminal which would be fully multiplexed and have transmitting and receiving capabilities for both voice and data. The equipment should have an RS232 port to accommodate the on-vehicle passenger check-in terminal and its peripheral equipment.

6.4 Automatic Vehicle Location

Some operators might wish to monitor the position of the vehicle at all stages of its trip cycle. Therefore, an added feature of the system could be automatic vehicle location equipment.

In its simpliest form, the vehicle location equipment would consist

of radio signal beacons set out at predetermined locations along the vehicle route. As the vehicle passed a transmitter beacon, its signal would be received by an on-board radio receiver. This signal would then be relayed to the control centre by radio data link where the position of the vehicle would be determined automatically and the information displayed.

6.5 Communication and Control

The central control system linked to the host computer would provide the necessary facilities for co-ordinating the following functions:

a. passenger boarding
b. terminal dispatch and monitoring
c. gathering, formatting and transmitting information to the main system computer for processing

The control centre could be located at the airport or elsewhere. The main advantage of on-airport location is that the control function could be combined with other similar operational activities at the airport leading to possible economies by sharing employees and equipment.

The computer would have the capacity to store flight lists (54 passengers plus standby and waiting lists) for as many flights as are likely to be boarding simultaneously. It would also store the status reports for such flights.

The data gathering and processing systems would have to handle the following information:

a. passenger statistics and summaries
b. flight movement data and loads
c. on time performance of vehicles and aircraft
d. equipment utilization
e. passenger billing information
f. statutory reporting information

This information would be assembled in the host computer and transmitted to the central computer in batch form.

The host computer would also be linked to fixed check-in and reservation terminals to accommodate those passengers who do not wish to use the mobile terminal. If the computer were required to serve other airport operations, additional peripheral equipment to accommodate these functions might also be required.

7.0 VEHICLE CONSIDERATIONS

Standard or modified highway and transit buses are often used to transport passengers from downtown air terminals to airport passenger terminals. At the airport. mobile apron lounges, some being standard buses and others incorporating very sophisticated mechanical systems to link with the aircraft are widely used to transport passengers between the airport terminal gate and the aircraft. This study examined the technical feasibility of a vehicle accommodating the combined road and apron related functions into a single unit.

7.1 Vehicle Selection

The vehicle should be capable of accommodating up to 50 passengers (30 seated) and their baggage. Two standard types of vehicles designed to operate on the public road system, and having the required capacity are transit and highway buses. Transit buses are widely available in a variety of body forms. They have low floors to facilitate fast and convenient entry and exit of passengers at street curb level. This is an advantage for urban operations where short stopping times are an important consideration and where easy access is required to accommodate the physically handicapped, passengers travelling with small children and the elderly. The low floor requires wheel wells at four locations in the vehicle and these limit the number and the layout of seats that can be provided. The vehicles usually do not have special facilities for holding baggage or for storage of heavy and bulky articles.

Highway buses are designed to serve passengers who are travelling long distances and who are often accompanied by heavy baggage and parcels. Their higher operating speeds combined with longer travel distances generally require that seating be available for all passengers and that a more comfortable environment be provided than that generally available on transit buses. In order to maximize seating and to provide adequate storage for baggage, road buses generally have their floor located above the wheels. The seats are efficiently laid out on a flat deck and the space below the floor is compartmentalized to accommodate baggage and parcels. Toilet facilities are often provided.

While either vehicle could be converted into a mobile terminal, the highway bus is preferred for the following reasons:

1. It has a higher floor and therefore the difference in elevation between it and the aircraft floor is reduced, thereby facilitating passenger transfer.

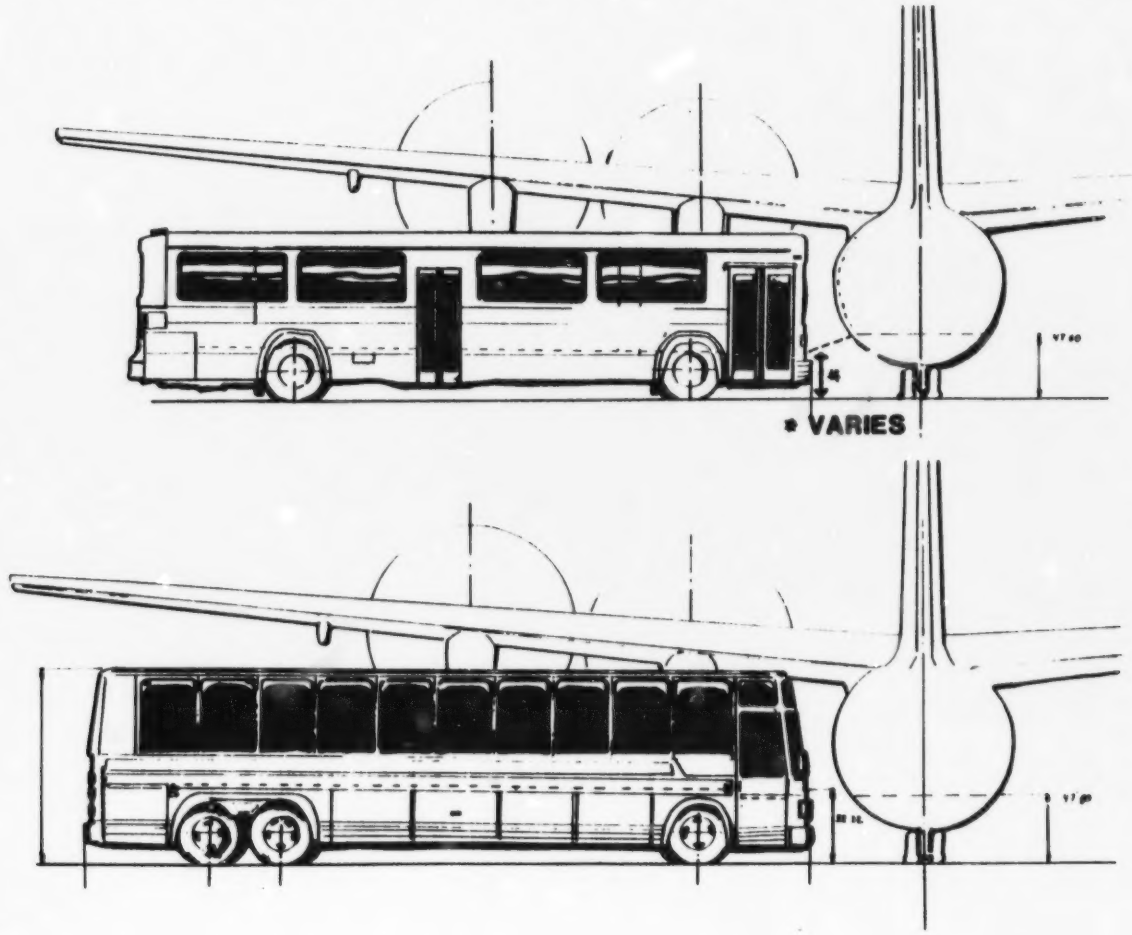


Figure 2 AIRCRAFT/BUS INTERRELATIONSHIP

2. The absence of wheel wells increases seating flexibility and capacity.

3. Underfloor storage space simplifies baggage handling.

4. Superior performance in applications involving long travel distances at high speeds.

Lower capacity operations than those assumed in this study could favour transit buses since both baggage handling and passenger seating could be accommodated at the same level if fewer passengers are to be transported.

7.2 Aircraft Loading System

A direct, weather-proof mechanical linkage between the road vehicle and the aircraft will be required. All of the aircraft considered have their loading doors on the side. Therefore, buses could load passengers from the front; from the side; or they could back up to the aircraft door and load passengers through the rear of the vehicle.

Rear loading was rejected because major modifications would be required to the engine compartment of most rear-engined buses. Furthermore, the risks involved in backing a large vehicle up to an aircraft would require the development of sophisticated guidance equipment before the procedure would be acceptable to air carriers. While both problems are capable of solution, the option was dropped because the two other loading arrangements appeared to be superior.

Front Loading

The proposed passenger connection between the vehicle and the aircraft requires that the bus be fitted with a telescoping ramp and cover which could be moved forward and retracted hydraulically or manually and would fit inside the bus beside the driver. The aircraft door would first be opened and a bus mounted extension would be pushed forward to mate with the aircraft. A flexible rectangular membrane would envelope the aircraft door opening to form a weather-tight seal. The operation of the linkage mechanism, whether hydraulic or manual, would be considerably less complex and costly than standard fixed aircraft loading bridges because the former could be very much smaller and level changes involved are much less.

Side Loading

The side loading option requires that the bus be parked parallel to the aircraft with its passenger linkage mechanism aligned with the aircraft loading door. The passenger connection would move at right angles to the centre line of the bus and would be similar to that described for the front loading case.

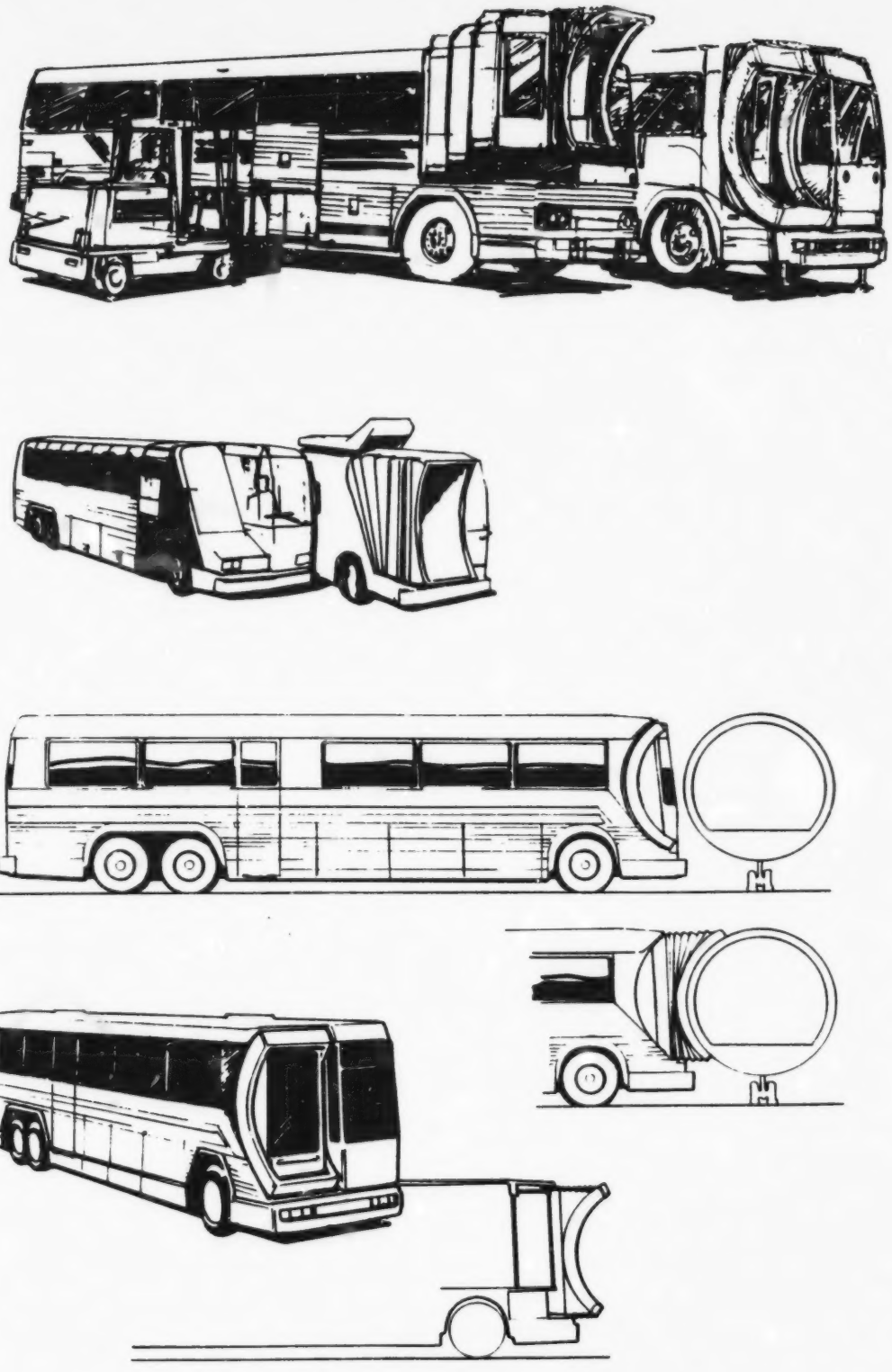


Figure 3 FRONT END EQUIPMENT OPTIONS

Most highway buses have little longitudinal space available in front of the wheel and this restricts the width of connection possible. Placing the connection behind the front wheel overcomes the space problem but with some aircraft would leave insufficient longitudinal separation between the wing and the cabin door to properly accommodate the vehicle. With the Dash 7, it would be possible to locate the connection either in front of or behind the front wheel.

Modifying the front of a standard bus to accommodate a wider linkage would not be practical in prototype development, but might be practical for production units. The bus extension that would be required is only a few centimetres for most models.

7.3 Passenger Entry and Baggage Handling

Passenger entry to the vehicle from the curb and baggage handling are closely related problems and the preferred arrangement would be for the passenger and his baggage to be checked in simultaneously. If the vehicle to aircraft linkage mechanism were located at the front of the bus, a second passenger loading door would have to be provided on the side since the normal entry door at the front would be blocked by the equipment. Passengers entering the vehicle through this side door could drop their bags on the curb for attendant loading, or could place the baggage into an underfloor baggage compartment themselves. Standby passengers would keep their bags until their seats were confirmed.

Another arrangement and possibly the preferred one, would be to have a single attendant check in both passengers and baggage at a side position on the bus near curb level. Checked baggage could be placed directly into the standard baggage compartment immediately behind the attendant. Standby passengers would again keep their bags with them until their seats were confirmed.

7.4 Feasibility and Costs

The preferred vehicle for prototype development would be a highway bus because it could provide more flexible seating; has a higher floor facilitating aircraft connections; and contains an underfloor baggage compartment which could be adapted for passenger baggage check-in. The side loading option appears to be most practical for prototype development purposes since it would involve the least modifications to the standard vehicle. It would however, require an additional side door for loading and unloading passengers at the curb. The proposed mechanically operated passage between the aircraft and the bus appears to be simple and could be fabricated and assembled by competent, conventional bus body shops.

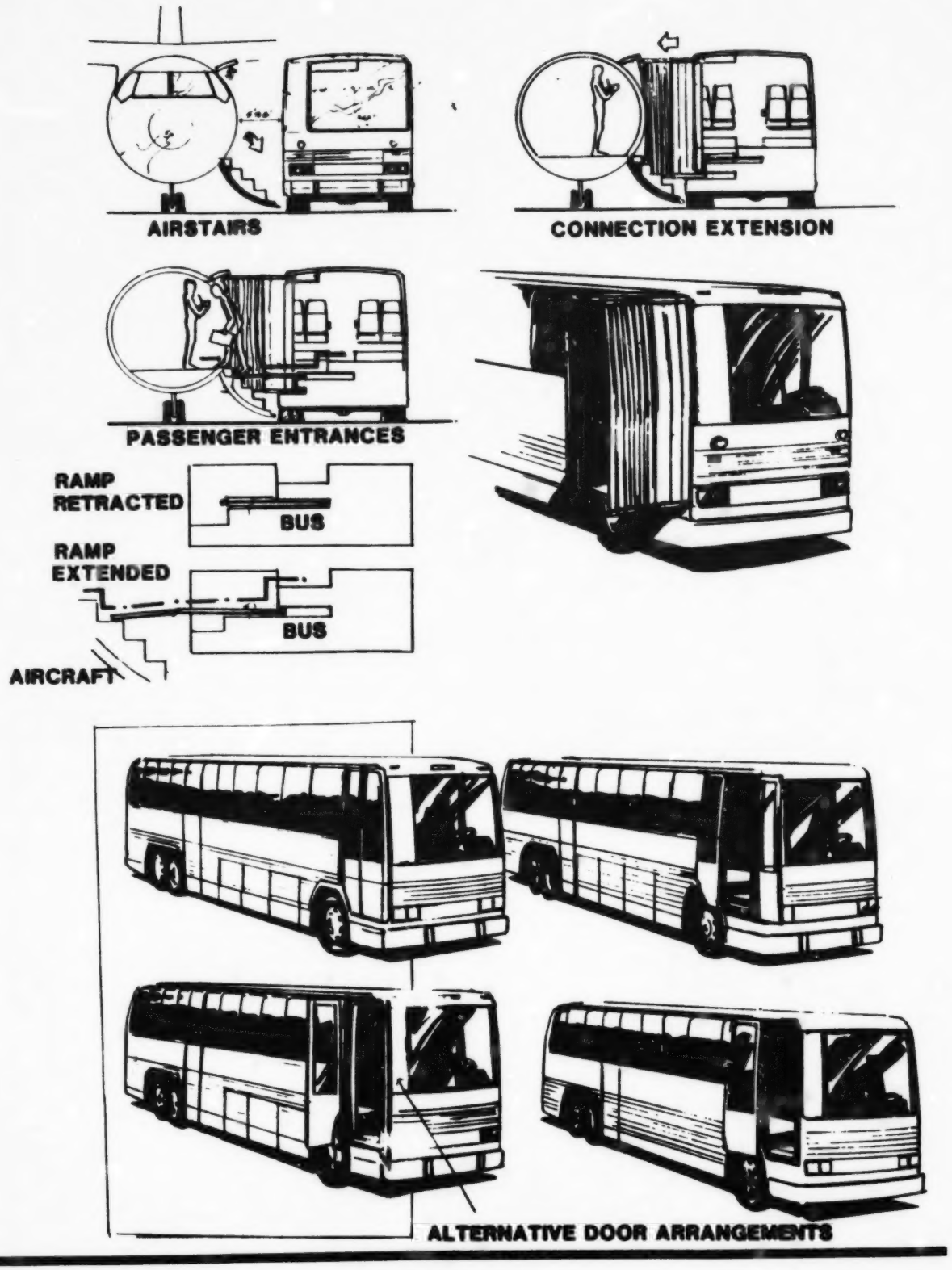


Figure 4 SIDE LOADING OPTION

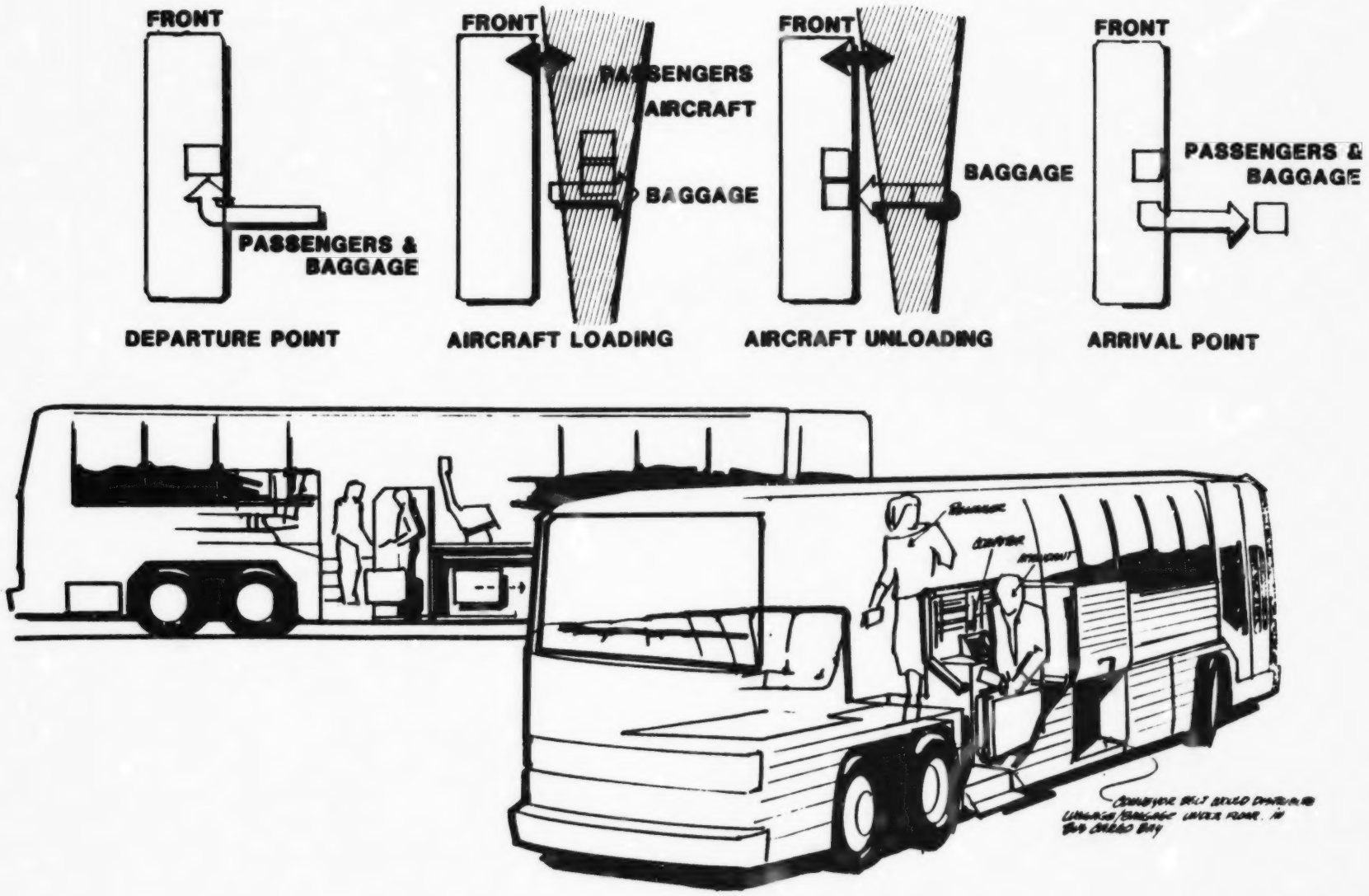


Figure 5 BAGGAGE HANDLING - SIDE LOADING CONCEPT

The design concept was developed only to the point where preliminary cost estimates could be made. Order of magnitude estimates for the operations and control systems indicated a cost of approximately $10,000. per unit excluding design and prototype development costs. The cost of the electronic equipment and software associated with the control centre is dependent upon the volume and complexity of the carrier operations. For demonstration purposes, a simple control centre would be established for approximately $15,000. and a further $25,000. to $30,000. would be required to develop computer software.

The cost of modifying a standard bus is difficult to estimate because of the lack of detailed drawings either for the connecting mechanism or for the modifications to the bus. However, indications are that a prototype unit for demonstration purposes could be developed by modifying an existing bus for approximately $70,000. The capital cost of an appropriate highway bus, having the necessary capacity would be approximately $200,000. The total approximate capital cost of the initial vehicle would therefore be $280,000. Additional costs would be incurred for system and vehicle design, computer software, testing, demonstrations and prototype development.